
TECHNICAL MANUAL

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**DIRECT SUPPORT AND GENERAL SUPPORT
MAINTENANCE MANUAL
FOR**

**CRANE, WHEEL MOUNTED:
20-TON AT 10-FOOT
RADIUS, 2 ENGINES, DIESEL ENGINE DRIVEN,
4x4 AIR TRANSPORTABLE**

**HARNISCHFEGER CORP. MODEL M320RT
(NSN 3810-00-275-1167)**

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HARNISCHFEGER CORP. MODEL 320RT
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2. File this change sheet in front of the publication for reference purposes.

By Order of the Secretary of the Army:

Official:

ROBERT M. JOYCE
Brigadier General, United States Army
The Adjutant General

E. C. MEYER
General, United States Army
Chief of Staff

Distribution:

To be distributed in accordance with DA Form 12-25B, Direct and General Support Maintenance Requirements for Crane, Wheel Mounted.

SAFETY PRECAUTIONS

BEFORE OPERATION

Make certain that the upper and the carrier have been deprocessed completely before servicing. Make certain that preservatives have been removed from crankcases, fuel tanks, gear cases, machine cases, and the like.

Fasten a tag near the radiator filler caps indicating the type antifreeze.

Before reeving any line, lay out line so there is no possibility of kinking during reeving process.

Do not set up carrier or crane near electrical power lines. Be sure to observe all local, state and Federal regulations regarding the safe minimum operating distance to power lines.

Personnel should use care to keep from spilling fuel, coolant and other liquids upon themselves. Exposed parts of the body should not come in contact with metal during cold weather, as serious and painful injury may result.

Turn radiator cap slowly and allow pressure to escape before removing it.

Disconnect battery cables before working on electrical components.

Lower attachment to the ground before attempting to adjust the boom hoist brake. Serious damage to the equipment or injury to personnel may otherwise result.

While in park abort condition the carrier will have no brakes. Always block wheels so as to prevent truck crane motion before placing the machine in park abort position. Do not remove blocking until the carrier is returned to normal brake system operation.

Make sure proper program card is installed in the load moment safety computer warning device.

DURING OPERATION

It is important that both carrier and crane operators avoid setting up or operating the crane near electrical power lines. Be sure to observe all local, state and Federal regulations regarding safe minimum operating distance to power lines.

Use care when swinging the upper or revolving frame without a boom. The crane will tend to be unbalanced toward the counterweight end.

Do not rely on the ratchet brake locks on front or rear drum brake pedals to suspend a load. The operator must remain in a position of readiness, with feet on the pedals, at all times that a load is suspended.

The boom hoist pawl must be engaged at all times, except when lowering the boom. Do not attempt to engage the boom hoist pawl when lowering the boom.

Do not attempt to raise the boom by means of the boom hoist lines if the boom tip is below ground level which supports the carrier. The angle of pull on the boom will be such that the boom may collapse before it can be pulled into the operating position.

Do not crank engine for more than 30 seconds continuously without allowing a two minute cooling period. If engine does not start after a few tries stop cranking. Determine cause and correct.

AFTER OPERATION

The boom hoist pawl must be engaged at all times except when lowering the boom.

Personnel should use care to keep from spilling fuel, coolant or other liquids upon themselves. Exposed parts of the body should not come in contact with metal during cold weather as serious or painful injury could result.

Turn radiator cap slowly and allow pressure to escape before removing it.

The swing brake is not used to stop the upper (revolving frame) from swinging while machine is in operation. It is used solely to prevent the revolving frame from turning while the machine is not in use, such as when it is being moved from place to place.

Be sure no hydraulic fluid comes into contact with any brake or clutch lining while performing any maintenance operation.

Disconnect battery cables before working on any electrical components.

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REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this publication direct to: US Army Tank-Automotive Command, ATTN: DRSTA-MB, Warren, MI 48090. A reply will be furnished to you.

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PART ONE

GENERAL

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

a. This manual contains instructions for the use of Direct Support and General Support personnel maintaining the model M320RT Rough Terrain Crane. It provides instructions for maintenance, as specified in the Maintenance Allocation Chart (MAC) which is beyond the scope of Operator/Crew or Organizational Maintenance personnel.

b. This manual is divided into three parts. Part one covers description and data. Part two covers repair instructions for the crane upper (revolving frame) portion of the truck crane. Part three contains instructions for repair of the carrier or truck portion of the crane. Maintenance personnel should read the instructions

contained in the manual prior to repairing the equipment.

NOTE

In this manual reference to the crane or upper portion of the vehicle and reference to the revolving frame are one and the same.

c. All publications applicable to this manual are listed in appendix A.

1-2. Forms and Records

Maintenance records and reports which are used by maintenance personnel at all levels are listed and prescribed in TM 38-750.

Section II. DESCRIPTION AND DATA

1-3. Description

a. A general description of the model M320RT rough terrain crane and information pertaining to the identification plates and equipment operating instructions are also contained in TM 5-3810-295-12.

b. Descriptions of specific components and assemblies pertinent to direct, general support personnel are detailed in this manual.

1-4. Tabulated Data

a. *General.* Maintenance data pertinent to direct and general support personnel is included in this paragraph. TM 5-3810-295-12 includes additional data and should be referred to as required.

b. *Tabulated Data.*

(1) *Truck crane.*

Manufacturer Harnischfeger Corporation
Model M320RT
Design Rough Terrain

(2) *Carrier engine.*

Manufacturer Cummins Engine Company
Model V903
Type Diesel
Bore 5.5 in
Stroke 4.75 in
Total displacement 903 cubic in
Compression 16.5: 1
Number of cylinders 8
Governor speed 2600 rpm, full load
Idle speed 625 ± 25 rpm
Horse power 269 at 2600 rpm, full load
500 ft/85° F.

Oil pressure (rated speed) 40 to 65 pounds per square inch
Oil pressure (idle speed) 5 to 25 pounds per square inch
Ignition timing 21.0° before top dead center
Cooling Liquid
Rotation at flywheel end counter clockwise
Firing order 1-5-4-8-6-3-7-2
Injection tappet clearance 0.010-in minimum
Intake Valves 0.012 in (hot or cold)
Exhaust Valves 0.025 in (hot or cold)
Electrical system 24 V

(3) *Upper engine.*

Manufacturer Detroit Diesel Allison
Model 5043-7200 (4-53)
Type Diesel
Bore 3.875 in
Stroke 4.5 in
Total displacement 212/Cubic in
Number of cylinders 4
Governor speed 2250 rpm full load
Idle speed 550 ± rpm
Horse power 97 HP at 2250 rpm, full load
Oil pressure (rated speed) 40-60 PSI (30 psi Min).
Oil pressure (idle speed) 5-7 psi
Rotation at flywheel end counter clockwise
Firing order 1-3-4-2
Injector tappet clearance
Intake valves None
Exhaust valves 0.025 inch (cold) 0.023 inch (hot)
Electrical system 24 V

Idler gear hub and spacer bolts

5/16 inch.....19-23 ft-lb (26-31 N • m)

3/8 inch40-45 ft-lb (54-61 N • m)

Injector clamp bolts20-25 ft-lb (27-34 N • m)

Air box cover bolts12-16 ft-lb (16-22 N • m)

Flywheel housing bolts25-30 ft-lb (34-41 N • m)

Connecting rod nuts.....25-30 ft-lb (34-41 N • m)

Fuel line nuts.....12-15 ft-lb (16-20 N • m)

Fuel connector20-28 ft-lb (27-38 N • m)

Rocker arm bracket bolts...50-55 ft-lb (68-75 N • m)

Flywheel bolts.....110-120 ft-lb (149-163 N • m)

Main bearing

cap bolts.....120-130 ft-lb (163-176 N • m)

Cylinder head bolts....170-180 ft-lb (230-244 N • m)

Crankshaft end bolt ...290-300 ft-lb (393-407 N • m)

Camshaft and balance

shaft nut.....300-325 ft-lb (407-441 N • m)

Governor control housing to flywheel

housing.....10-12 ft-lb (14-16 N • m)

Blower drive assembly to flywheel

housing.....20-25 ft-lb (27-34 N • m)

Governor drive gear retaining

nut.....125-135 ft-lb (169-183 N • m)

Injector filter caps65-75 ft-lb (88-102 N • m)

Injector nut (crown valve) ..55-65 ft-lb (75-88 N • m)

Blower drive gear

pilot bolt25-30 ft-lb (34-41 N • m)

Blower timing gear-to-rotor

shaft bolts.....25-30 ft-lb (34-41 N • m)

Blower thrust washer retaining

bolt25-30 ft-lb (34-41 N • m)

Front end plate

cover bolts.....20-25 ft-lb (27-34 N • m)

Air inlet adapter-to-blower

bolts16-20 ft-lb (22-27 N • m)

Air inlet housing-

to-adapter.....16-20 ft-lb (22-27 N • m)

Governor assembly to blower front end plate

bolts20-24 ft-lb (27-33 N • m)

Blower drive support to blower rear end

plate bolts.....20-24 ft-lb (27-33 N • m)

Flywheel housing to blower drive

support bolts20-24 ft-lb (27-33 N • m)

Blower drive gear cover

bolts20-24 ft-lb (27-33 N • m)

Blower thrust washer retaining

bolt54-59 ft-lb (73-80 N • m)

Blower end plate-to-block

bolts55-60 ft-lb (75-81 N • m)

Oil filter center stud40-50 ft-lb (54-68 N • m)

When torque requirements are not specified, use Table 1-1, General Torque Values (Except for Engines) and Table 1-2, General Torque Values for Engines.

Table 1-1. General Torque Values (Except Engines)

SAE grade no. bolt body size (inches) - (thread)	1 or 2 Torque				5 Torque			
	minimum		maximum		minimum		maximum	
	ft-lb	N • m	ft-lb	N • m	ft-lb	N • m	ft-lb	N • m
1/4 - 20	4	5	6	8	7	9	9	12
1/4 - 28	5	7	7	9	9	12	11	15
5/16 - 18	10	14	12	16	16	22	18	24
5/16 - 24	12	16	14	19	18	24	20	27
3/8 - 16	17	23	19	26	30	41	32	43
3/8 - 24	19	26	21	28	34	46	36	49
7/16 - 14	27	37	29	39	48	65	50	68
7/16 - 20	29	39	31	42	54	73	56	76
1/2 - 13	38	52	40	54	73	99	77	104
1/2 - 20	40	54	42	57	83	113	87	118
9/16 - 12	50	68	52	71	105	142	115	156
9/16 - 18	54	73	56	76	115	156	125	169
5/8 - 11	81	110	85	115	145	196	155	210
5/8 - 18	93	126	97	132	165	224	175	237
3/4 - 10	100	136	110	149	265	359	275	373
3/4 - 10	110	149	120	163	290	393	300	407
7/8 - 9	155	210	165	224	390	529	400	542
7/8 - 14	170	230	180	244	425	576	440	597
1 - 8	230	312	240	325	580	786	600	813
1 - 14	240	325	250	339	650	881	670	908

Table 1-2. General Torque Values for Engines

SAE grade no. body size inches	5 Torque				8 Torque			
	minimum		maximum		minimum		maximum	
	ft-lb	N · m	ft-lb	N · m	ft-lb	N · m	ft-lb	N · m
1/4	9	12	10	14	12	16	14	19
5/16	19	26	21	28	27	37	30	41
3/8	33	45	37	50	45	61	50	68
7/16	53	72	60	81	75	102	85	115
1/2	80	108	90	122	115	156	130	176
9/16	115	156	130	176	160	217	180	244
5/8	160	217	180	244	220	298	250	339
3/4	290	393	320	434	400	542	450	610
7/8	420	569	470	637	650	881	730	990
1	630	854	710	963	970	1315	1090	1478
1 1/8	850	1152	950	1288	1380	1871	1550	2101
1 1/4	1200	1627	1350	1830	1940	2630	2180	2956
1 1/2	2000	2712	2300	3118	3300	4474	3700	5016
1 3/4	3300	4474	3700	5016	5300	7185	6000	8135
2	5000	6779	5500	7457	8000	10846	9000	12202

Bolt Identification Guide

SAE grade no.

- 5 Will have three equally spaced radial lines. Quenched and tempered carbon steel.
 8 Will have six equally spaced radial lines. Quenched and tempered medium carbon alloy or medium carbon steel.

Notes for table 1-2

1. Use minimum torque values when bolts and nuts are reused during servicing.
2. Torque values listed are for rigid joints without gaskets or compressable material.
3. Listed torque values are for threads lubricated with engine oil or chassis grease. When other lubricants or materials are used, multiply standard assembly torques by the following factors:
 - a. 0.85 when metallic plated bolts or nuts are used.
 - b. 0.70 when Molykote, white lead or similar mixtures are used as lubricants.
 - c. 0.90 when hardened surfaces are used under the nut or bolt head.
 - d. 1.20 when Loctite is used on the threads of standard bolts and nuts.
 - e. 1.25 when taper head bolts are used (with bolt head torque).
 - f. 1.40 when Loctite is used on taper head bolt threads (with bolt head torqued).

PART TWO CRANE (UPPER)

CHAPTER 2 DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS AND EQUIPMENT

NOTE

References to crane upper and to the revolving frame mean the same thing.

2-1. Special Tools and Equipment

There are no special tools or equipment needed to perform direct or general support maintenance on the

M320RT truck crane.

2-2. Maintenance Repair Parts

Repair parts for the M320RT truck crane are listed and illustrated in the repair parts list TM 5-3810-295-34P (to be published).

Section II. TROUBLESHOOTING

2-3. Scope

a. This section contains troubleshooting or malfunction information and tests for locating and correcting most of the troubles which may develop in the M320RT crane. Each malfunction or trouble symptom for an individual component, unit, or system is followed by a list of tests or inspections necessary for you to determine probable causes and suggested corrective actions for you to remedy the malfunction.

b. This manual cannot list all possible malfunctions that may occur or all tests or inspections, and corrective actions. If a malfunction is not listed (except when malfunction and cause are obvious), or is not corrected by listed corrective actions, you should notify higher level maintenance.

c. Table 2-1 lists the common malfunctions that you may find during the operation or maintenance of the M320RT crane or its components. You should perform the test/inspections and corrective actions in the order listed.

2-4. Troubleshooting

Refer to table 2-1 and troubleshoot the M320RT as required.

NOTE

Before you use this table, be sure you have performed all normal operational checks. If you have a malfunction which is not listed in this table, notify the next higher level of maintenance.

Table 2-1 Troubleshooting

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

1. ENGINE WILL NOT CRANK WHEN STARTER BUTTON IS PUSHED.

Step 1. Check electrolyte level.

If electrolyte level is low, add clean or distilled water until level is three-fourths of an inch above separator plates. Charge battery as described in TM 5-3810-295-12.

Step 2. Check battery case for cracks.

Refer to TM 5-3810-295-12 and replace battery as described.

Step 3. Check for loose, corroded or broken battery cables.

Clean or replace cables and/or terminals.

Step 4. Check for faulty starter solenoid. (Generally a defective solenoid will produce a clicking sound when starter button is pushed.)

Replace solenoid as described in TM 5-3810-295-12.

Step 5. Check engine for damage resulting from lack of engine coolant or damaged mechanical parts. If the engine cannot be hand cranked one revolution it is an indication of internal damage.

Refer to chapter 4 and repair engine as required.

Step 6. Check for broken or loose connection in starter circuit.

Splice or replace faulty wire or terminal.

Table 2-1 Troubleshooting—Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
		<p>Step 7. Check for faulty starter. Starter may not engage ring gear, or starter windings may be shorted. Replace faulty starter as described in paragraph 3-8 (crane) or 13-2 (carrier).</p> <p>Step 8. Check for missing teeth on engine ring gear. Replace ring gear as described in chapter 4 (crane) or chapter 14 (carrier).</p>
2. ENGINE CRANKS BUT WILL NOT START.		<p>Step 1. Check fuel level. If vehicle is out of fuel, refill it.</p> <p>Step 2. Check for restricted air intake. Clean or replace air cleaner as described in TM 5-3810-295-12.</p> <p>Step 3. Check for air leaks in vacuum lines. Repair air leaks or replace lines.</p> <p>Step 4. Check for restricted fuel line or injector. Locate restriction and remove.</p> <p>Step 5. Check fuel pump for damage. Repair fuel pump as described in paragraph 3-49 (crane) or paragraph 13-21 (carrier).</p> <p>Step 6. Check for incorrect injector and valve timing. Correct timing as described in chapter 4 (crane) or chapter 14 (carrier).</p> <p>Step 7. Check for burned or sticking valves. Repair valves as described in paragraph 4-4 (crane) or paragraph 14-18 (carrier).</p> <p>Step 8. In low temperature areas, check for defective starting aid. Repair starting aid as described in TM 5-3810-295-12.</p> <p>Step 9. Check for low compression due to broken piston ring(s) or scored cylinder liner. Repair liner or replace rings as required. See chapter 4 or 14.</p> <p>Step 10. Check for faulty governor or injector rack settings. Refer to chapter 4 (crane) or chapter 14 (carrier) and repair or adjust governor.</p> <p>Step 11. Check for stuck air shut-down valve in air inlet. Refer to chapter 3 (crane).</p> <p>Step 12. Check for restricted exhaust system. Remove restriction from exhaust system.</p>
3. ENGINE MISSES.		<p>Step 1. Check for poor quality fuel. Drain fuel tank and refill with appropriate quality fuel.</p> <p>Step 2. Check for clogged or leaking fuel lines. Clean lines or replace broken tubing.</p> <p>Step 3. Check for restricted air intake (dirty air cleaner). Clean or replace air cleaner as described in TM 5-3810-295-12.</p> <p>Step 4. Check for clogged injector spray holes. Clean or replace injectors as described in paragraph 3-61 (crane) or paragraph 14-13 (carrier).</p> <p>Step 5. Check for worn or broken piston rings. Replace broken rings as described in paragraph 4-36 (crane) or paragraph 14-31 (carrier).</p> <p>Step 6. Check governor adjustment. Adjust governor linkage as described in paragraph 3-55 (crane).</p> <p>Step 7. Check engine timing. Time engine as described in paragraph 14-15.</p> <p>Step 8. Check engine air blower (crane). Refer to paragraph 3-37 (crane) and repair blower.</p>

Table 2-1 Troubleshooting—Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
	Step 2.	Locate noise. Listen for internal damage. Possible sources of damage are water pump, piston rings, and rod bearings. Repair or replace damaged parts.
5. COOLANT TEMPERATURE TOO LOW.		
	Step 1.	Test the thermostat as described in TM 5-3810-295-12. Replace faulty thermostat per instructions contained in TM 5-3810-295-12.
	Step 2.	Check for damaged thermostat seals. Damaged seals will cause a continued flow of coolant past thermostat. Replace thermostat seals as described in TM 5-3810-295-12.
COOLANT TEMPERATURE TOO HIGH (ENGINE OVERHEATS).		
	Step 1.	Check engine coolant level. If coolant level is too low add antifreeze mixture.
	Step 2.	Water pump V belt missing or slipping. Replace or adjust V belt as described in TM 5-3810-295-12.
	Step 3.	Check radiator and heater hoses for leaks, cracks, or loose connections. Repair or replace damaged hoses and hose clamps.
	Step 4.	Check radiator core for damage or excessive dirt. Refer to paragraph 3-13 (crane) or paragraph 13-35 (carrier) and replace or clean radiator as required.
	Step 5.	Rotate water pump by hand and listen for metallic grinding noise. If pump does not rotate smoothly the bushing is probably worn. Refer to paragraph 3-19 (crane) or paragraph 13-16 (carrier) for repair or replacement of water pump.
	Step 6.	Remove thermostat and test as described in TM 5-3810-295-12. Replace defective thermostat as described in TM 5-3810-295-12.
	Step 7.	Check engine lubricant level. If engine lubricant level is low it will cause engine to overheat. Check for oil leaks and repair as required. Fill as necessary per LO 5-3810-295-12-1, -2, and -3.
	Step 8.	Internal water lines may be restricted. Drain and flush cooling system as described in TM 5-3810-295-12.
	Step 9.	Check to see if engine is operating under excessive strain due to overload, brake drag or operating too long in low gear. Eliminate cause of excessive strain.
7. ENGINE EMITS EXCESSIVE SMOKE.		
	Step 1.	Check for dirty air cleaner or restricted air intake lines. Clean or replace air cleaner as described in TM 5-3810-295-12 and/or remove restriction from air intake lines.
	Step 2.	Check for excessive exhaust back pressure due to restriction in exhaust system. Remove restriction from exhaust system.
	Step 3.	Check for restriction in fuel lines. Remove restriction from fuel lines.
	Step 4.	Check for plugged or damaged fuel injectors. Clean, adjust or replace fuel injectors as described in paragraph 3-61 (crane) or paragraph 14-12 (carrier).
	Step 5.	Check for head gasket blow-by due to loose head bolts or damaged gasket. Replace head gasket as described in paragraph 4-9 (crane) or paragraph 14-16 (carrier) or tighten head bolts if required.
	Step 6.	Check for broken piston ring(s). Replace rings as described in paragraph 4-38 (crane) or paragraph 14-31 (carrier), or overhaul engine, if necessary, as described in DMWR-5-3810-295.

Table 2-1 Troubleshooting—Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
	Step 7.	Check for incorrect valve and injector timing. Time valves and injectors as described in paragraph 4-9 (crane) and chapter 14-15 (carrier).
	Step 8.	Check injector adjustment. Adjust injectors as described in paragraph 3-59 (crane) or paragraph 14-14 (carrier).
	Step 9.	Worn or scored pistons or cylinder liners. Repair pistons or liners as described in paragraph 4-38 or paragraph 14-31 (carrier) or overhaul engine as described in DMWR-5-3810-295.
8. INSUFFICIENT POWER.		
	Step 1.	Check injector adjustment. Adjust injector as described in paragraph 3-59 (crane) or paragraph 14-14 (carrier).
	Step 2.	Check for incorrect fuel pressure.
	Step 3.	Check air intake lines and air cleaner for restrictions. Clean intake lines and air cleaner or replace cleaner. See TM 5-3810-295-12.
	Step 4.	Check for restricted fuel lines. Clean fuel lines as described in TM 5-3810-295-12.
	Step 5.	Check for leaks in fuel lines. Repair leaks or replace damaged fuel lines as described in TM 5-3810-295-12.
	Step 6.	Check for plugged injectors. Clean injectors as described in paragraph 3-64 (crane) or paragraph 14-12 (carrier).
	Step 7.	Check for loose head bolts or damaged gasket (loss of compression). Tighten head bolts or replace gasket as described in paragraph 4-9 (crane) or paragraph 14-21 (carrier).
	Step 8.	Check for incorrect valve and injector timing. Time valve and injectors as described in paragraph 4-8 (crane) or paragraph 14-15 (carrier).
	Step 9.	Check for internal damage such as: worn cylinder liners, broken piston rings, and damaged rod bearings. Repair engine as described in paragraph 4-38 (crane) or paragraph 14-31 (carrier) or overhaul engine, if necessary, as described in DMWR 5-3910-295.
9. EXCESSIVE FUEL CONSUMPTION.		
	Step 1.	Check for incorrect fuel pressure. Replace or repair fuel pump as described in paragraph 3-52 (crane) or paragraph 13-22 (carrier).
	Step 2.	Check for leaks in fuel system. Repair leaks or replace damaged lines as described in TM 5-3810-295-12.
10. LOW LUBRICATING OIL PRESSURE.		
	Step 1.	Check for low oil level. Fill crankcase with appropriate oil.
	Step 2.	Check for restriction in oil suction line. Clean oil passages as required.
	Step 3.	Check for incorrect bearing clearance. Reinstall bearings as described in paragraph 4-38 (crane) or paragraph 14-38 (carrier).
	Step 4.	Check engine compression and decide if engine requires overhaul. Overhaul engine as described in DMWR 5-3810-295.
11. LUBRICATION OIL TEMPERATURE TOO HIGH.		
	Step 1.	Check for water pump damage. Repair or replace water pump as described in paragraph 3-19 (crane) or paragraph 13-16 (carrier).
	Step 2.	Check for faulty or damaged thermostat. Replace thermostat as described in TM 5-3810-295-12.
	Step 3.	Damaged or clogged oil cooler. Repair or replace oil cooler as described in paragraph 3-25 (crane) or paragraph 13-11 (carrier).

Table 2-1 Troubleshooting—Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
12. TRANSMISSION SELECTOR LEVER WILL NOT ENGAGE.		
	Step 1. Check linkage for loose, binding or disconnected parts.	Adjust linkage as described in TM 5-3810-295-12 or if necessary, repair or replace as described in paragraph 15-2.
13. TRANSMISSION ENGAGES BUT FAILS TO TRANSMIT DRIVING TORQUE.		
	Step 1. Check transmission fluid level while engine is hot.	Refer to current LO 5-3810-295-12-1, -2, and -3 and fill transmission to proper level.
	Step 2. Check for internal damage to the torque convertor and transmission (excessive noise).	Overhaul as described in DMWR 5-3810-295.
14. CRANE DRIVE CHAIN EXCESSIVELY NOISY.		
	Step 1. Check for broken or damaged chain.	Repair or replace chain as described in TM 5-3810-295-12.
	Step 2. Check for worn or damaged sprocket.	Repair or replace sprocket as described in TM 5-3810-295-12.
	Step 3. Check for improper adjustment of drive chain.	Adjust chain as described in TM 5-3810-295-12.
	Step 4. Insufficient or use of incorrect lubricant.	Refer to current LO 5-3810-295-12-1, -2 and -3 and lubricate drive chain.
15. CRANE HOIST GEARS NOISY.		
	Step 1. Check gear teeth for excessive wear.	Replace gear as described in paragraph 5-19.
	Step 2. Check bearings for excessive wear or damage.	Replace bearings as described in chapter 5-19.
	Step 3. Check hoist shaft for bends or cracks.	Replace hoist shaft as described in chapter 5-19.
	Step 4. Check for improper or insufficient lubrication.	Refer to current LO 5-3810-295-12-1, -2 and -3 and lubricate as required.
16. CRANE SWING GEAR NOISY OR VIBRATES DURING OPERATION.		
	Step 1. Check gear teeth for excessive wear or breaks.	Replace gear as described in paragraph 5-42.
	Step 2. Check for broken or damaged chain.	Repair or replace chain as described in TM 5-3810-295-12.
	Step 3. Check for worn or damaged sprocket as described in TM 5-3810-295-12.	Repair or replace sprocket as described in TM 5-3810-295-12.
	Step 4. Check for improper adjustment of drive chain.	Adjust chain as described in TM 5-3810-295-12.
	Step 5. Insufficient or use of incorrect lubricant.	Refer to current LO 5-3810-295-12-1, -2 and -3 and lubricate drive chain.
	Step 6. Check bearing for scoring or excessive damage.	Replace bearing as described in paragraph 5-42.
	Step 7. Check horizontal swing shaft (7, fig. 5-11) for bends or breaks.	Replace shaft as described in paragraph 5-42.
	Step 8. Check for improper and insufficient lubrication.	Refer to the current LO 5-3810-295-12-1, -2 and -3 and lubricate as required.
17. CRANE BOOM OR HOIST OPERATION SPORADIC.		
	Step 1. Check drive shaft for bends or other damage.	Replace drive shaft as described in paragraph 5-19.
	Step 2. Check to see if inner boom gear is binding.	Replace gear bushing.
	Step 3. Check for broken or damaged shaft bearings.	Replace shaft bearings.

Table 2-1 Troubleshooting—Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
18. REVOLVING FRAME WOBBLES OR WILL NOT SWING.		
	Step 1.	Check rollers for excessive wear or other damage. Replace hook rollers as described in TM 5-3810-295-12.
	Step 2.	Check swing clutches for maladjustment. Adjust swing clutch as described in TM 5-3810-295-12.
	Step 3.	Check vertical swing shaft for breaks or excessive damage. Replace or repair vertical swing shaft or related parts as described in paragraph 5-54.
	Step 4.	Check for improper or insufficient lubrication. Refer to current LO 5-3810-295-12-1, -2 and -3 and lubricate revolving frame.
19. WHEELS ARE EXCESSIVELY NOISY DURING CARRIER OPERATION.		
	Step 1.	Inspect for wheel bearing damage as described in paragraph 16-6. Replace wheel bearing as described in paragraph 16-10.
20. CARRIER AXLE VIBRATES OR IS EXCESSIVELY NOISY DURING CARRIER OPERATION.		
	Step 1.	Check differential lubricant level. Refer to current LO 5-3810-295-12-1, -2 and -3 and fill axle to proper level.
	Step 2.	Check universal joints for damage or lack of lubrication. Lubricate universal as described in TM 5-3810-295-12 or, if necessary, refer to paragraph 15-7 and replace universal joints as described.
	Step 3.	Remove differential and check for excessive wear or damage. Repair or replace differential as described in paragraph 16-12.
	Step 4.	Check planetaries for excessive wear or damage. Repair or replace planetaries as described in paragraph 16-12.
	Step 5.	Check axle shafts for damage. Replace axle shafts as described in chapter 16.
21. CARRIER BRAKE ACTION TOO SLOW OR INSUFFICIENT.		
	Step 1.	Check brake shoe adjustment. Adjust brake shoes as described in TM 5-3810-295-12.
	Step 2.	Check brake shoe linings for excessive wear. Adjust brake shoes as described in paragraph 16-18 or replace as described in paragraph 16-22 if necessary.
	Step 3.	Check brake lines for breaks, obstructions or leaks. Refer to paragraph 18-1 and repair or replace damaged components as required.
	Step 4.	Check air supply for low pressure. Repair or replace air compressor as described in paragraph 13-26.
22. BRAKES DRAG WHEN PEDAL IS RELEASED.		
	Step 1.	Check for improper brake shoe adjustment (too tight). Adjust brake shoes as described in TM 5-3810-295-12.
	Step 2.	Check brake release valve for damage. Repair or replace valve as described in chapter 18.
23. BRAKES GRAB WHEN APPLIED.		
	Step 1.	Check for improper brake shoe clearance. Adjust brake shoes as described in TM 5-3810-295-12.
	Step 2.	Check brake shoe linings for oil or grease spots. Determine and correct cause of oil or grease leaks. Clean or replace brake shoes or linings as described in paragraph 16-22.
	Step 3.	Check brake drums for excessive wear (out-of-round). Replace brake drums.
	Step 4.	Check brake shoes for damage or excessive wear. Replace brake shoes as described in paragraph 16-22.
	Step 5.	Check brake chamber diaphragm for leaks (damaged unit or loose connections). Tighten fittings or replace damaged chamber as described in paragraph 18-2.

Table 2-1 Troubleshooting—Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
24. HYDRAULIC SYSTEM COMPONENTS SLUGGISH OR INOPERATIVE.		
	Step 1.	Check hydraulic reservoir fluid level. Refer to LO 5-3810-295-12-1, -2 and -3 and replenish hydraulic fluid as necessary. Also perform step 3.
	Step 2.	Sporadic or sluggish operation of hydraulic components may indicate air in system. Bleed system as described in TM 5-3810-295-12.
	Step 3.	Check system for leaks. Tighten any loose connections and/or replace any damaged lines or fittings.
	Step 4.	Check the component in which the problem seems to exist for damage. Repair or replace damaged component as described in chapter 20.
25. LSTC FUSE FAILURE LIGHTS "ON."		
	Step 1.	Perform test 4 of table 8-1. Perform corrective action indicated in table 8-1.
26. LSTC BLUE FLOATS/TIRES LIGHTS "OFF" OR WILL NOT SWITCH.		
	Step 1.	Perform in sequence tests 3, 14, 15, 16, 17, 18 and 19 of table 8-1. Perform corrective action indicated in table 8-1.
27. LSTC GREEN, ORANGE OR RED WARNING LIGHTS "OFF" OR ALWAYS "ON."		
	Step 1.	Perform in sequence tests 16, 17, 18, 29 and 30 of table 8-1. Perform corrective action as indicated in table 8-1.
28. BOOM ANGLE METER READS OFF SCALE EITHER BELOW 0 OR ABOVE 90 CONTINUOUSLY.		
	Step 1.	Check to see if boom is above 0°. Raise boom above 0°.
	Step 2.	Check to see if meter is stuck. Tap meter lightly.
	Step 3.	Check meter zero adjustment. Adjust meter zero.
	Step 4.	Perform in sequence tests 13, 16, 17, 20, 21 and 27 of table 8-1. Perform corrective action indicated in table 8-1.
	Step 5.	Perform in sequence tests 1 through 27 of table 8-1. Perform corrective action indicated in table 8-1.
29. BOOM ANGLE METER DOES NOT INDICATE WHEN BOOM IS RAISED.		
	Step 1.	Check to see if meter is stuck. Tap meter face lightly.
	Step 2.	Check to see that angle transducer pendulum is unlocked and free to swing. Unlock angle transducer pendulum.
	Step 3.	Perform in sequence tests 13, 16, 17, 20, 21, 22 and 27 of table 8-1. Perform corrective action as indicated in table 8-1.
30. BOOM ANGLE METER READING IS IN ERROR.		
	Step 1.	Check meter zero adjustment. Adjust meter zero.
	Step 2.	Check that the angle transducer pendulum swings freely. Loosen pendulum so that it will swing freely.
	Step 3.	Check angle transducer calibration. Calibrate angle transducer as described in paragraph 8-6.
	Step 4.	Perform in sequence tests 13, 16, 17, 20, 21, 22 and 27 of table 8-1. Perform corrective action as indicated in table 8-1.
31. BOOM ANGLE METER FLUCTUATES RANDOMLY.		
	Step 1.	Perform in sequence tests 20, 21, and 22 of table 8-1. Perform corrective action as indicated in table 8-1.
	Step 2.	Perform in sequence tests 13, 16, 17, 20, 21, 22 and 27 of table 8-1. Perform corrective action as indicated in table 8-1.

Table 2-1 Troubleshooting—Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
32. PERCENT CAPACITY METER READS ZERO WITH BOOM SUPPORTED BY GUYLINES.		
	Step 1.	Check to see if meter is stuck. Tap meter face lightly.
	Step 2.	Perform in sequence tests 6, 7, 8, 9, 10, 11, 12, 16, 17, 20, 21, 22, 23, 24, 25, 26, 29 and 30 of table 8-1. Perform corrective action as indicated in table 8-1.
33. PERCENT CAPACITY METER BELOW ZERO WITH BOOM SUPPORTED BY GUYLINE.		
	Step 1.	Check to see if meter is stuck. Tap meter face lightly.
	Step 2.	Check meter zero adjustment. Adjust meter zero with LSTC switch to "OFF."
	Step 3.	Check to see if angle transducer pendulum is locked. Unlock pendulum.
	Step 4.	Check leads A, B, C and D of pre-amplifier for proper wiring. Correct wiring per figure 8-2.
	Step 5.	Perform in sequence tests 6, 7, 8, 9, 10, 11, 12, 16, 17, 20, 21, 22, 23, 24, 25, 27, 29, and 30. Perform corrective action as indicated in table 8-1.
34. PERCENT CAPACITY METER READS BEYOND 100% WITH BOOM ON GROUND AND GUYLINES SLACK.		
	Step 1.	Check to see if meter is stuck. Tap meter face lightly.
	Step 2.	Check meter zero with LSTC switch "OFF." Adjust meter zero.
	Step 3.	Check that meter is zero with LSTC switch to "RUN." Null output as described in paragraph 8-6.
	Step 4.	Perform in sequence tests 6, 7, 8, 9, 10, 11, 12, 16, 17, 20, 21, 22, 23, 24, 25, 26, 29, and 30 of table 8-1. Perform corrective action as indicated in table 8-1.
35. PERCENT CAPACITY METER IS LOW OR HIGH FOR RATED LOADS AT THE RATED RADII.		
	Step 1.	Check to see if meter is stuck. Tap on meter face lightly.
	Step 2.	Check "Floats/Tires" switch is in correct position and proper program card is installed. Place "Floats/Tires" switch in the correct position. Install proper program card.
	Step 3.	Check zero of meter with boom on the ground and guyline cables slack and LSTC switch "OFF." Adjust meter zero.
	Step 4.	Check zero of meter with LSTC switch to zero check. Meter shall read zero $\pm 1\%$. Replace Lode Safe T computer.
	Step 5.	Check to see if load cell is free in cage assembly. Install load cell properly.
	Step 6.	Check calibration of angle transducer by verifying the readings taken across "S" to "L" pins at 50° as described in paragraph 8-6. Calibrate angle transducer.
	Step 7.	Check to see boom hoist reeving is proper and gantry is in proper position. Reeve boom hoist as illustrated in TM 5-3810-295-12.
	Step 8.	Perform in sequence tests 1 to 31 inclusive of table 8-1. Perform corrective action as indicated in table 8-1.
	Step 9.	Check indication with a known load to proper radius. Replace load cell.
6. PERCENT CAPACITY METER FLUCTUATES RANDOMLY.		
	Step 1.	Check for an open shield connection or moisture in cables, connector or pre-amplifier enclosure. Repair open shield and dry any moisture found.

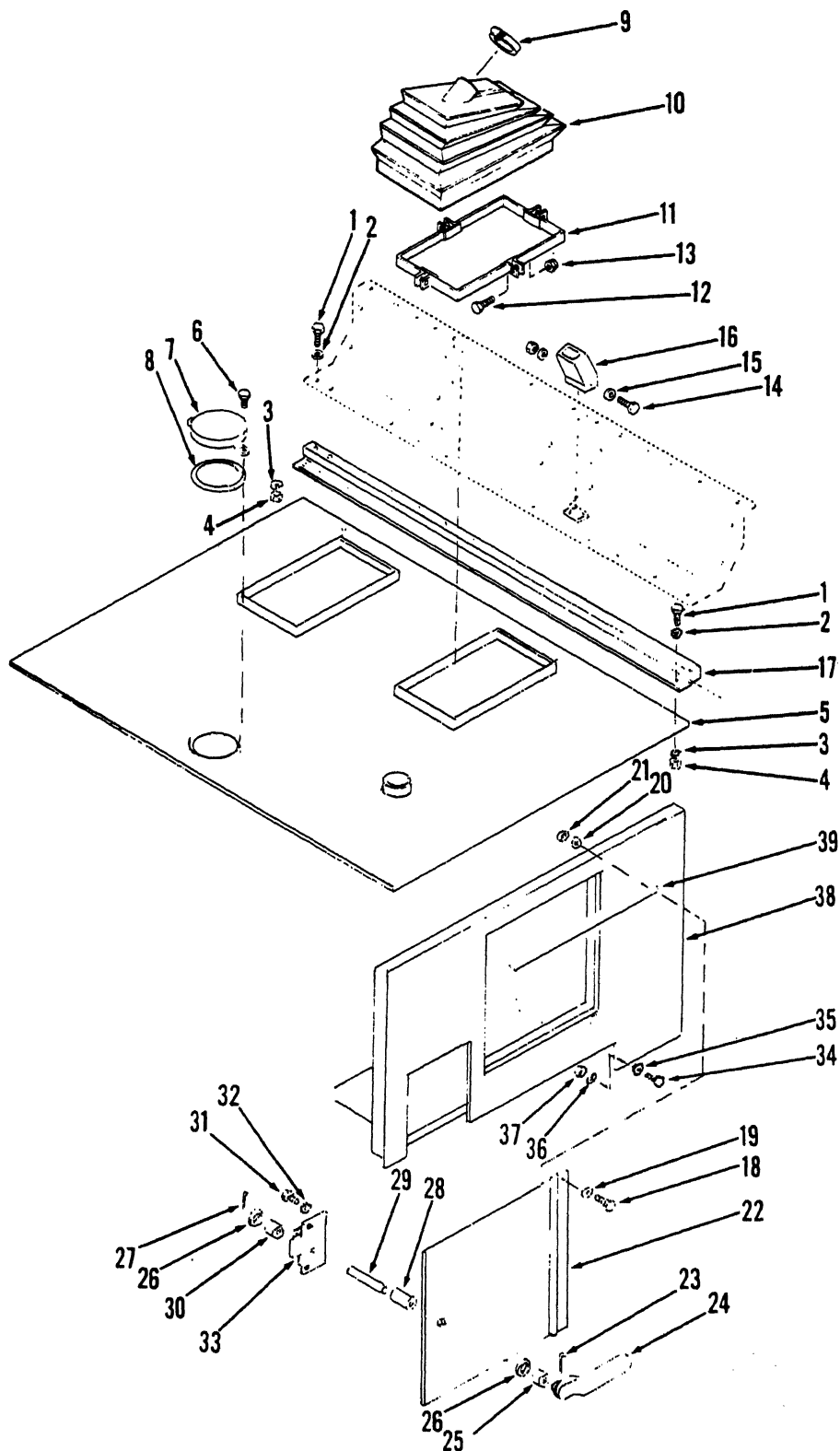
Table 2-1 Troubleshooting—Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
		Step 2. Perform in sequence tests 10, 11, 12, 16, 17, 19, 20, 21, 22, 23, 24 and 25 of table 8-1. Perform corrective action as indicated in table 8-1.
37. WARNING BELL RINGS CONTINUOUSLY.		Step 1. Check to see if angle transducer pendulum is not locked and is free to swing. Unlock or free angle transducer pendulum.
		Step 2. Check angle pre-set knobs for incorrect settings. Set low angle knob fully CCW and high angle knob fully CW.
		Step 3. Check to see that cable connections between angle transducer and LSTC console are tight. Tighten all loose connections.
		Step 4. Check for damaged angle transducer cable as described in paragraph 8-5. Repair defective cable.
		Step 5. Perform in sequence tests 1 through 31 of table 8-1. Perform corrective action as indicated in table 8-1.
38. WARNING BELL DOES NOT RING WHEN MACHINE HAS REACHED 100% CAPACITY PER RATING PLATE.		Step 1. Check wiring from P-4 to bell. Repair defective wiring.
		Step 2. Check bell winding (36 ohm) and connections. Replace warning bell.
39. WARNING BELL AND RED LIGHT DO NOT OPERATE AT 100% CAPACITY PER RATING PLATE.		Step 1. Perform tests 29 and 30 of table 8-1. Perform corrective action as indicated in table 8-1.
		Step 2. Perform in sequence tests 16, 17 and 18 of table 8-1. Perform corrective action as indicated in table 8-1.
40. LOW FLOW THROUGH TRANSMISSION OIL COOLER WITH LOW TORQUE CONVERTER OUT PRESSURE.		Step 1. Defective by-pass valve spring in transmission control valve (Fig. 15-5). Replace by-pass valve spring.
		Step 2. By-pass valve in transmission control valve partially open (Fig. 15-5). Check for worn or damaged by-pass ball seat.
		Step 3. Excessive converter internal leakage, Para 12-7.1(h). Remove, disassemble and repair converter, replacing all worn or damaged parts.
		Step 4. Excessive clutch leakage in transmission, Para 12-7.1(f) and (g). Remove, disassemble and repair transmission, replacing all worn or damaged parts.
41. LOW FLOW THROUGH TRANSMISSION OIL COOLER WITH HIGH TORQUE CONVERTER OUT PRESSURE.		Step 1. Restricted oil cooler, indicated if transmission lube pressure is low, Para 12-7.1(i). Backflush and clean oil cooler, Para 15-19.
		Step 2. Restricted oil cooler line. Clean or replace oil cooler line.
		Step 3. Lube oil ports in transmission. Clogged indicated if transmission lube pressure is high, Para 12-7.1(i). Clean transmission lube lines.

Table 2-1 Troubleshooting—Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
42. CONVERTER OIL OVERHEATS, PARA 12-7.1(b).	Step 1. Worn converter oil sealing rings, Para 12-7.1(h).	Remove, disassemble and repair converter.
	Step 2. Worn converter charging pump, Para 12-7.1(e).	Replace converter charging pump.
	Step 3. Transmission oil level low, Para 12-7.1(b).	Add oil to proper level.
	Step 4. Converter charging pump suction hose taking air.	Tighten suction hose connections or replace hose.
43. NOISY TORQUE CONVERTER.	Step 1. Worn coupling gears.	Replace gears, Fig. 15-11.
	Step 2. Worn converter charging pump, Para 12-7.1(e).	Replace charging pump, Para 15-18.
	Step 3. Worn or damaged torque converter bearings.	Disassemble and replace faulty bearings, Fig. 15-11.

- 1 Cap screw
- 2 Sealing washer
- 3 Lock washer
- 4 Nut
- 5 Engine cover
- 6 Thumb screw
- 7 Radiator access cover
- 8 Rubber channel
- 9 Boot clamp
- 10 Gantry leg boot
- 11 Clamp boot
- 12 Cap screw
- 13 Locking nut
- 14 Cap screw
- 15 Lock washer
- 16 Cable cover
- 17 Connecting bar
- 18 Cap screw
- 19 Sealing washer
- 20 Lock washer
- 21 Nut
- 22 Compartment door
- 23 Cotter pin
- 24 Latch handle
- 25 Spacer
- 26 Flat washer
- 27 Cotter pin
- 28 Spacer
- 29 Latch shaft
- 30 Spacer
- 31 Cap screw
- 32 Lock washer
- 33 Latch assembly
- 34 Cap screw
- 35 Sealing washer
- 36 Lock washer
- 37 Nut
- 38 Right engine panel
- 39 Rain gutter
- 40 Cap screw
- 41 Sealing washer
- 42 Lock washer
- 43 Nut
- 44 Engine air shutter
- 45 Cap screw
- 46 Sealing washer
- 47 Lock washer
- 48 Nut
- 49 Engine rear panel
- 50 Cap screw
- 51 Sealing washer
- 52 Lock washer
- 53 Nut
- 54 Door assembly
- 55 Cotter pin
- 56 Door latch handle
- 57 Spacer
- 58 Flat washer
- 59 Cotter pin
- 60 Spacer
- 61 Door latch shaft
- 62 Spacer
- 63 Cap screw
- 64 Lock washer
- 65 Latch assembly
- 66 Compartment support

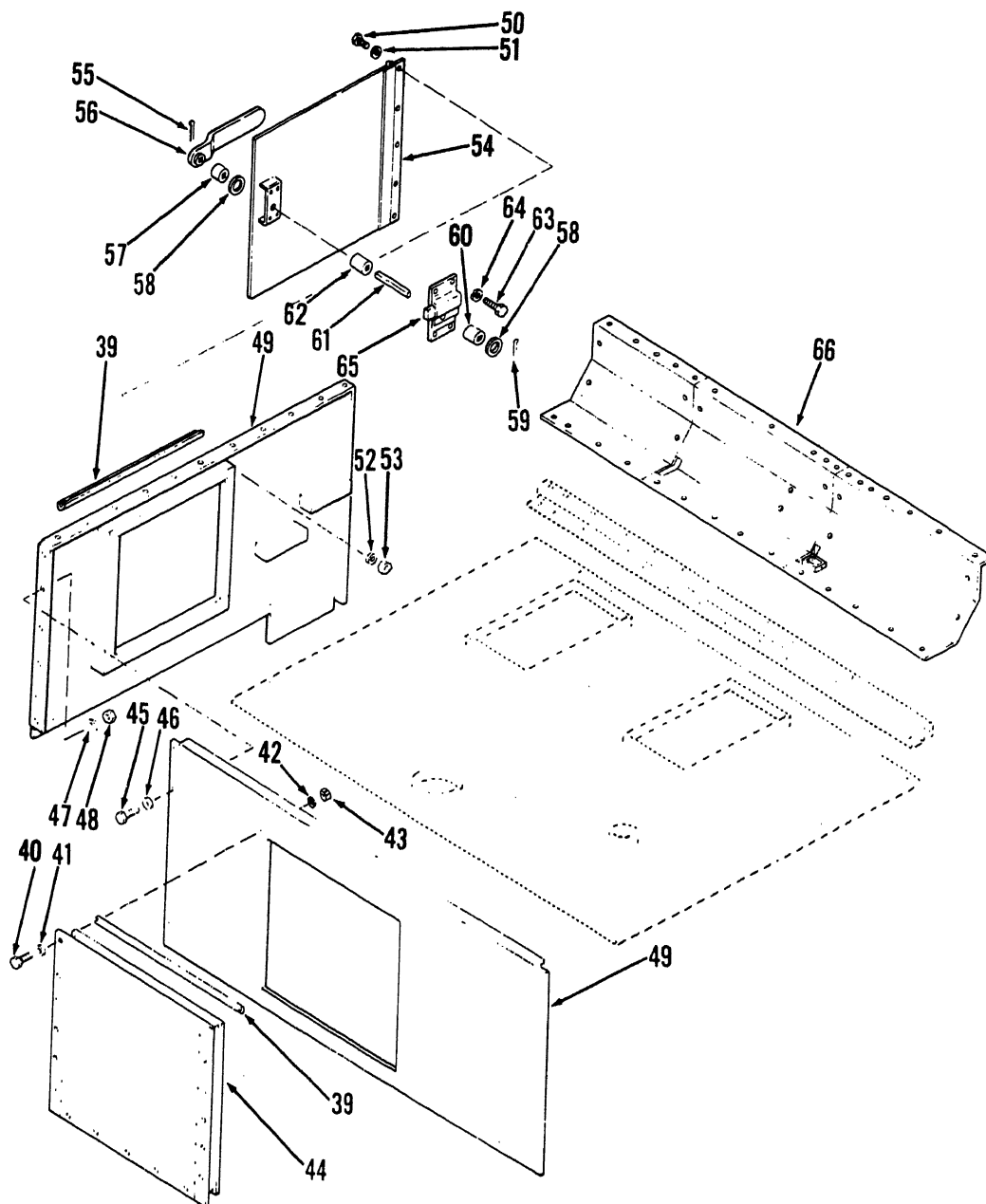


TA033140

Figure 2-1 Crane sheet metal (sheet 1 of 7).

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Figure 2-1. Crane sheet metal (sheet 2 of 7).

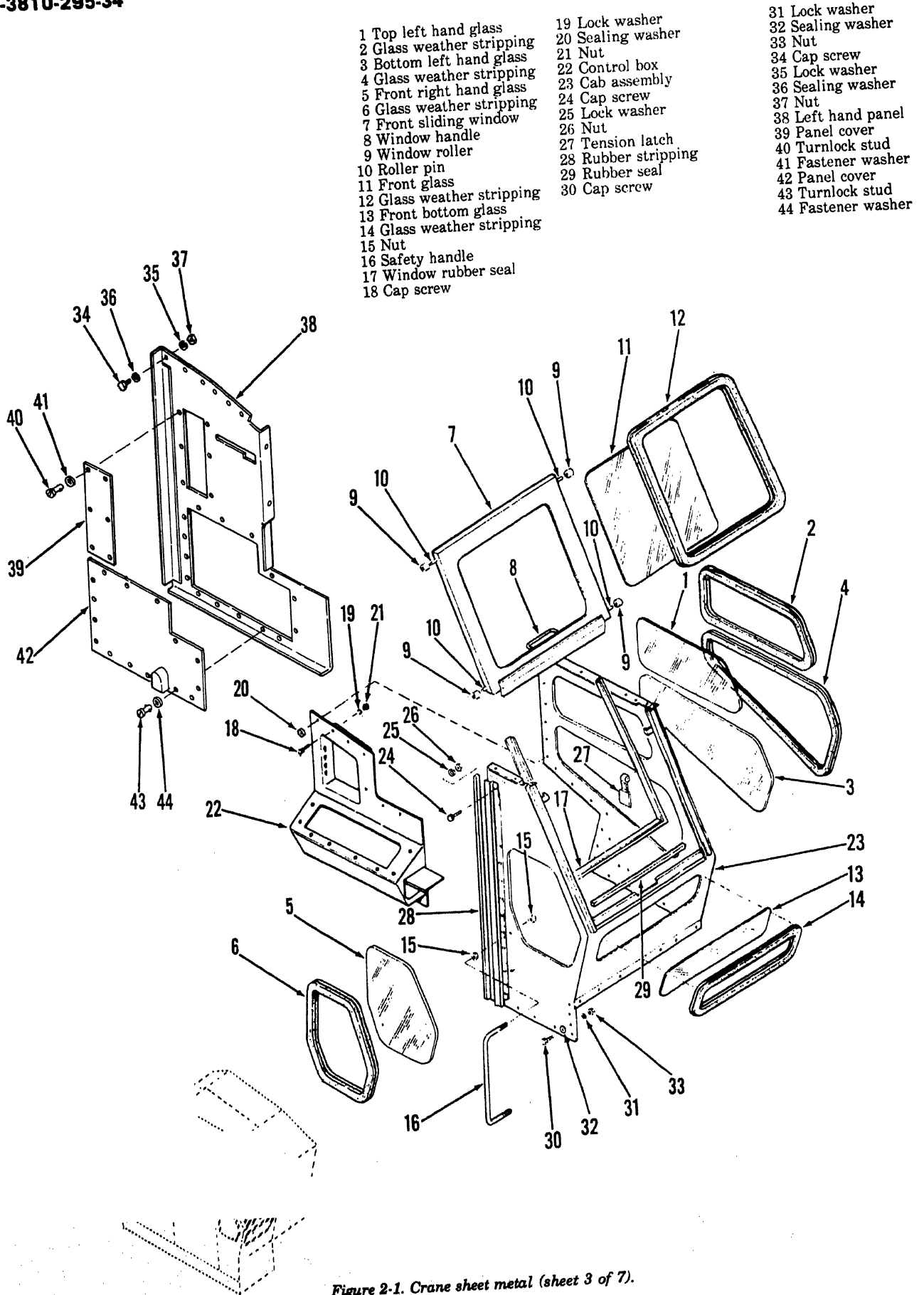
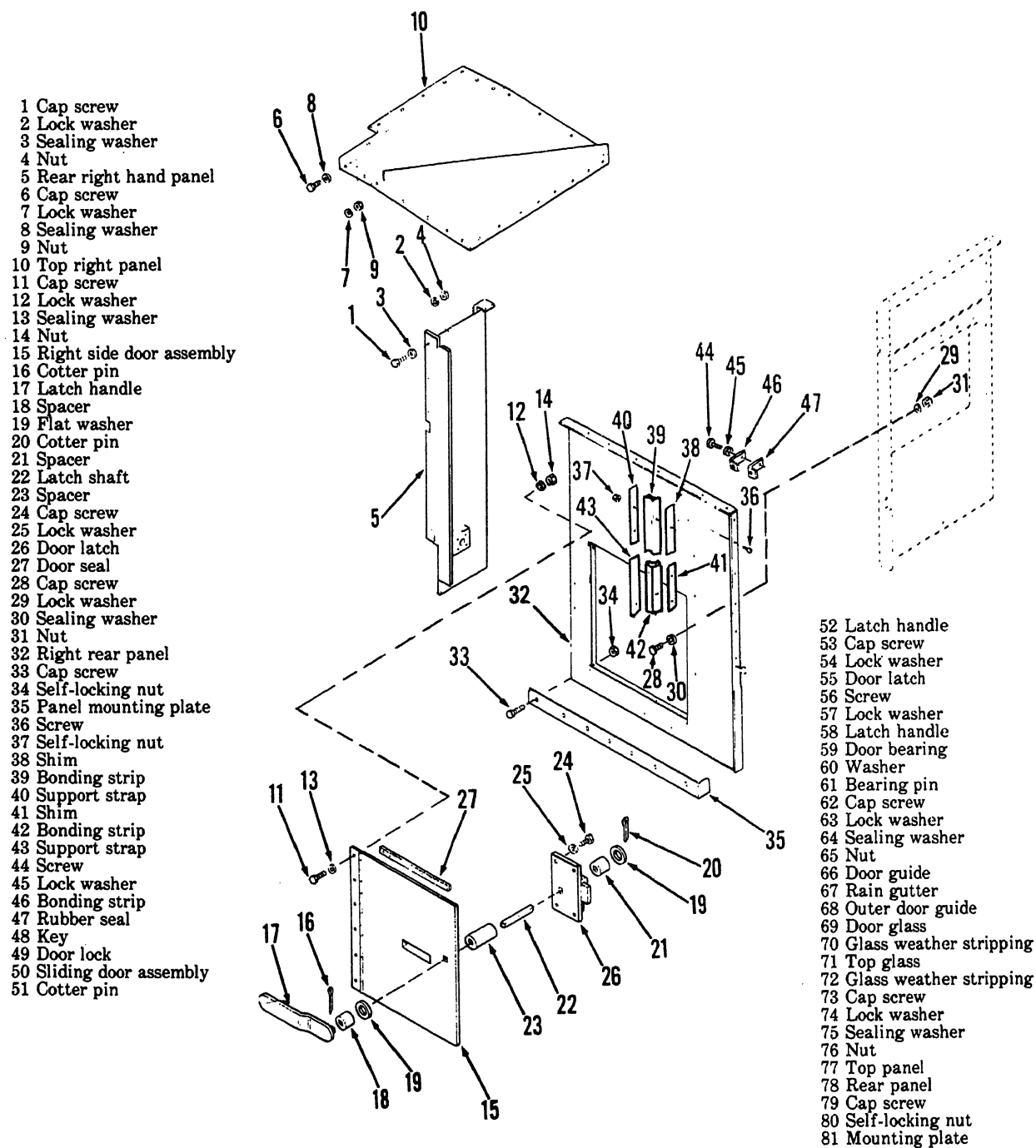
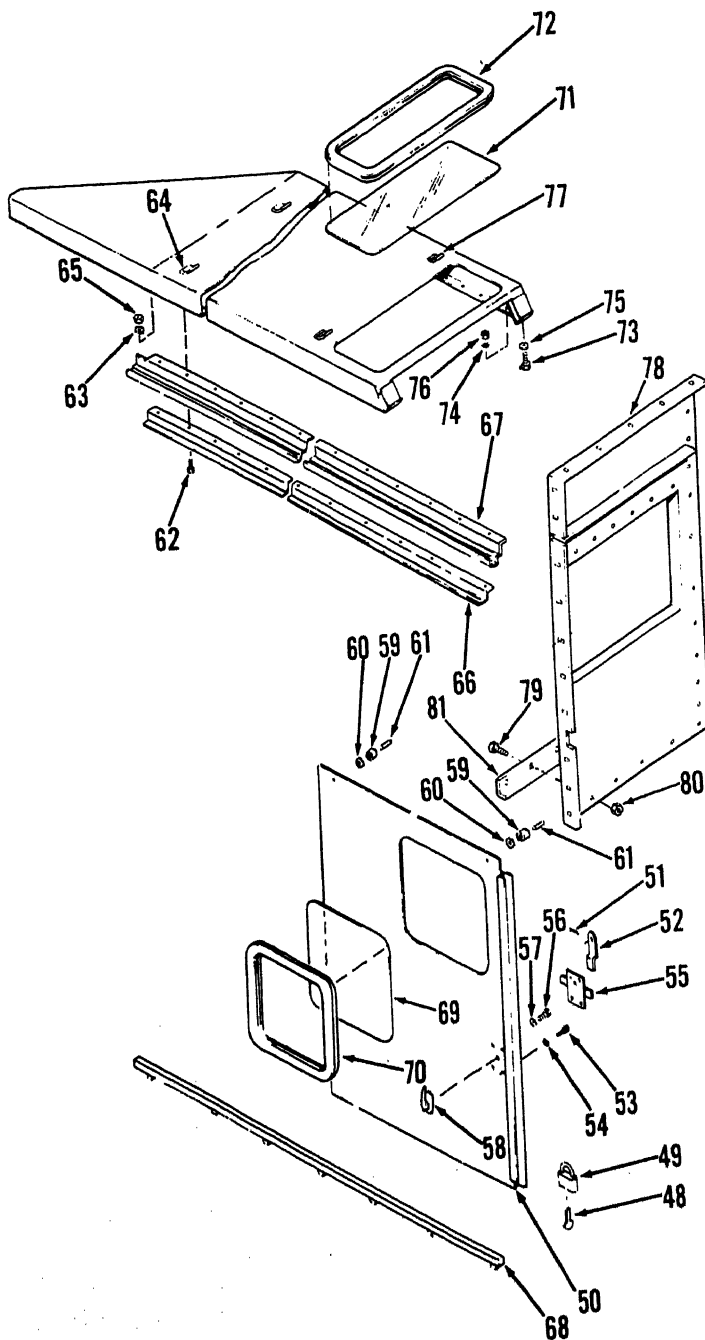


Figure 2-1. Crane sheet metal (sheet 3 of 7).



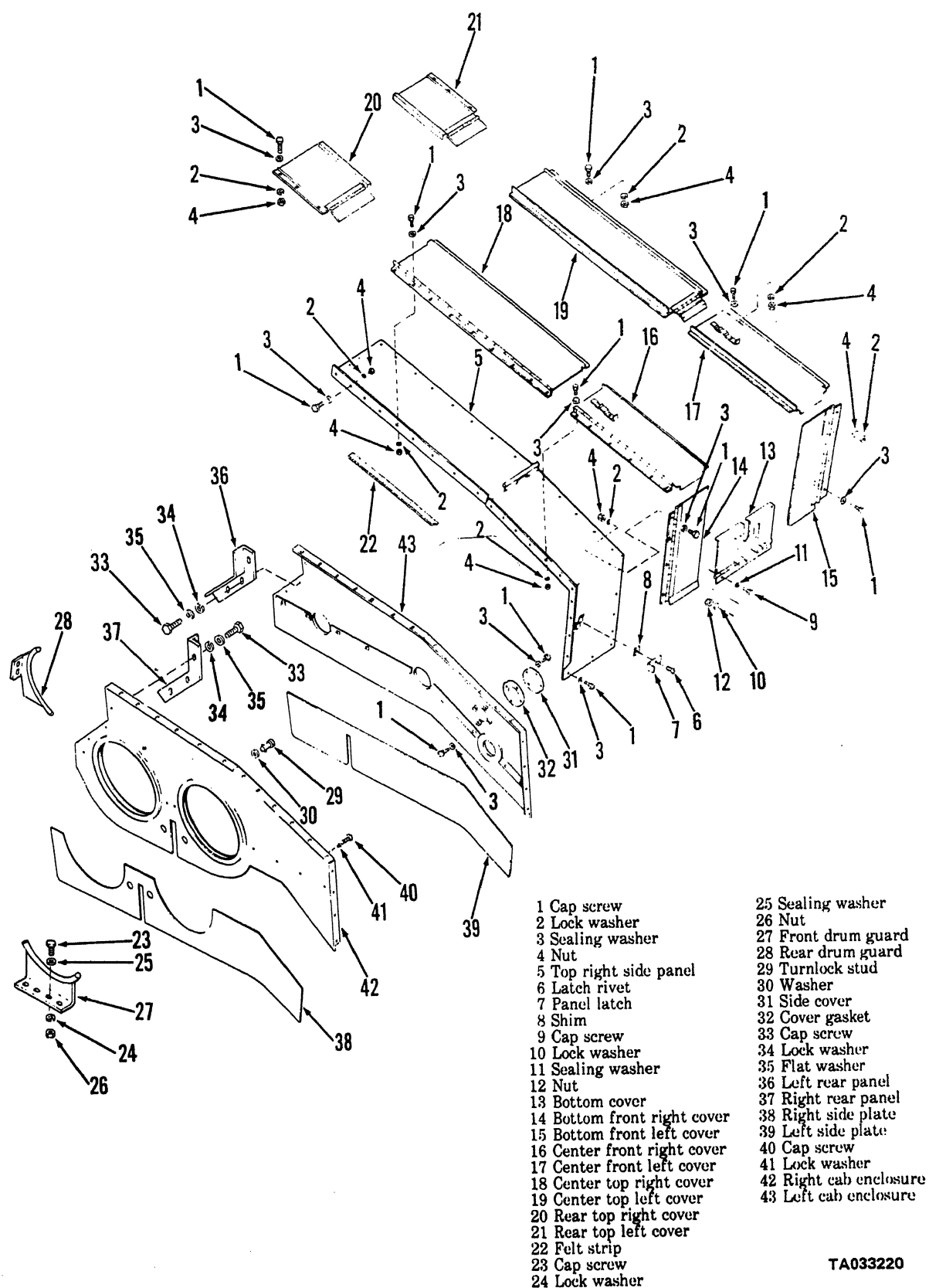
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Figure 2-1. Crane sheet metal (sheet 4 of 7).



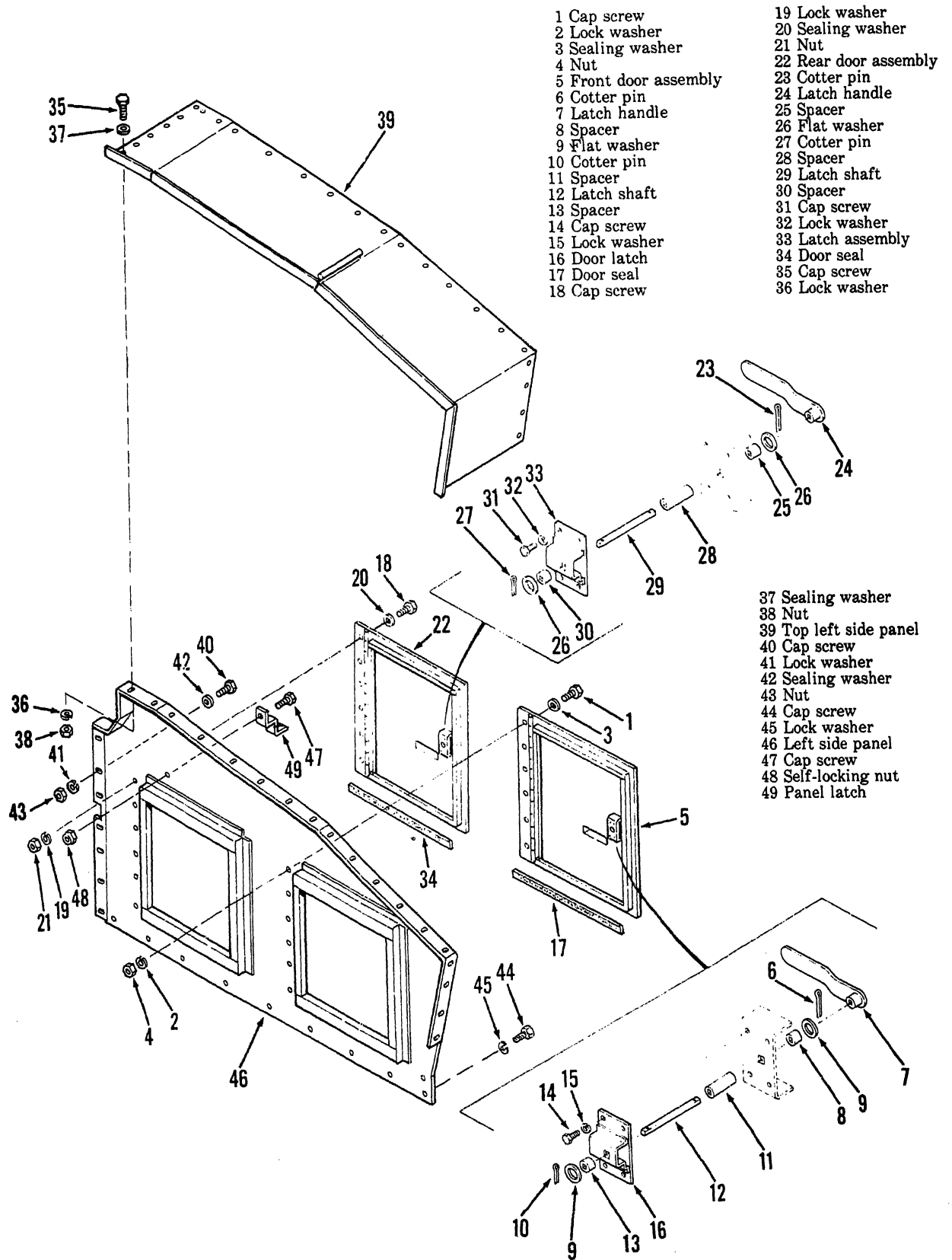
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Figure 2-1. Crane sheet metal (sheet 5 of 7).



TA033220

Figure 2-1. Crane sheet metal (sheet 6 of 7).



TA033221

Figure 2-1. Crane sheet metal (sheet 7 of 7).

Section III. GENERAL MAINTENANCE

2-5. General Removal and Disassembly Instructions

Prior to attempting any disassembly procedures the following points should be read and adhered to.

- a. Make sure crane is properly shut-down, blocked and supported (as required for safety) prior to performing any maintenance functions.
- b. Always make use of suitable slings, jacks, and supports when removing heavy assemblies.
- c. Always try to provide a clean working area especially when disassembling engine, engine accessories, transmissions, axles, wheels, assemblies and similar sealed and lubricated sub-assemblies.
- d. When an assembly has been removed, immediately re-install attaching hardware to prevent losing those parts.
- e. Insure that all hoses, tubes and wiring assemblies are properly tagged or otherwise identified to insure proper reassembly and installation.
- f. Disassembly should be limited to the point required for repair or replacement. The exception to this is for further inspection of the assembly.
- g. Never use a torch to remove any part unless the part to be removed is already damaged and the heat will not damage any surrounding parts. If a screw, bolt or nut is hard to remove, try a rust removing fluid or lubricant before using excessive heat or force.
- h. Refer to figure 2-1 to remove any sheet metal required to gain access to component or assemblies being removed.

2-6. General Cleaning and Inspection Instructions

In general, any part that has been removed and/or disassembled should be cleaned and inspected as follows:

- a. Clean all parts using a suitable cleaning solvent such as Federal Specification P-D-680. A scraper or steel brush may be required on some external components. Dry all parts thoroughly. Lubricate those assemblies that require it.
- b. Inspect all parts that receive torque or other strain for cracks, bends or excessive wear.
- c. Inspect gears for worn, cracked or chipped teeth.
- d. Inspect all bearings, bushings and sleeves for excessive wear, scoring or other damage.
- e. Inspect threaded parts for damaged threads.
- f. Inspect, carefully, all seats in which a seal gasket or packing will seat for rough edges.
- g. Inspect any passages and grease fittings to insure that they are clean and open.

2-7. General Repair and Replacement Instructions

- a. Replace all oil seals, gaskets and preformed packings. Make sure replacement gasket is the same thickness as the old gasket.

- b. Smooth any rough edges on which a seal, gasket or packing will seat.

- c. Smooth out all nicks, burrs, or rough spots on shafts, bores, pins or bushings.

2-8. General Reassembly Instructions

- a. Insure that bearing assemblies have been pre-packed with suitable bearing grease.
- b. Never force a bearing on a shaft if the fit is exceedingly tight. Polish the shaft and heat the bearing. To heat the bearing, immerse it completely in an oil bath or heat in an oven.
- c. Insure that bearings and spacers are reassembled in the same position and order in which they were disassembled.
- d. Always use a torque wrench when specified.

2-9. Welding Procedure for "T-1" Steel

- a. *General.* The upper turret flange is the only place in this machine where high strength "T-1" steel is used. The following instructions cover the methods to be used in welding this high strength alloy steel.

- b. *Electrode Selection.* The single most important thing to remember in the welding of high strength steels is to use the right electrode. Be sure to use only electrodes with "low-hydrogen" coatings for manual arc welding. An alternative method would be to use a welding method, such as inert gas shielded arc, or submerged arc, which is inherently "low-hydrogen." Hydrogen is the main cause of failure in welding high strength alloy steel. Hydrogen which remains in the weld will cause cracking when the welded steel cools. This cracking is not visible at the surface of the weld, but will occur beneath the visible surface. In order to insure the proper selection of low-hydrogen rods, use rods with classification numbers ending in 15, 16, 18, or 28. Samples of acceptable rods are E7028, E8015, E9016, and E11018. When welding "T-1" steel to a lower strength steel, the electrode strength should be the same as recommended for the lower strength steel, but must remain of the low-hydrogen type. Also, when doing submerged-arc or inert-gas welding, the wire or wire-flux combination need only match the lower strength steel. Correct handling of electrodes, fluxes, and shielding gases is also very important. Low-hydrogen coated electrodes and fluxes, when exposed to the air, will pick up moisture. Moist coating will generate underbead cracking, even though, when dry, they are classified as "low-hydrogen." Make sure the electrodes are dry as follows:

- (1) If your electrodes are in an undamaged metal container and you are sure the container was air tight before opening, put the electrodes immediately into a ventilated holding oven set at 250/300°F. Note that moisture control in E70 rods is not as good as in higher strength rods, and it is therefore particularly impor-

tant that these rods be baked before use.

(2) If the electrode can was not air tight, or if the package was a cardboard "moisture-proof" box, place the electrodes in a baking oven. Check to see if temperature and baking time is on shipping label; if not, one hour at 800°F is average but, baking at 800°F should never exceed one hour and 15 minutes. Be sure the oven is vented for air circulation. After baking, the electrodes should be placed, while still warm, in a holding oven at 250/300°F.

(3) Never take more than a half-hour's supply of electrodes from the holding oven. If electrodes are out of the holding oven longer than one-half hour, repeat step 2.

(4) Table 2-2 should be used to establish proper current-voltage settings.

c. *Heat.* The production of acceptable quality welds in "T-1" steel depends on never exceeding the required maximum heat. Use less heat than is required for ordinary steels, so that the weld area will cool down rather quickly. As long as "T-1" steel can cool rapidly it will develop good, tough welds. The only one practical way to control the time required for cooling is to control the amount of heat put into the weld. Table 2-3 provides the recommended preheat and interpass temperatures for the thickness of upper turret flange steel provided on this machine.

d. *Welding Procedures.* The straightforward stringer bead method is preferred for welding "T-1" steel. Do not use the "full weave" method, except as described below. Normally, the proper method is to fill the

groove with a succession of stringer beads. In the event that a vertical weld is required, it is permissible to weave, but be sure to restrict the weave to a minimum of two electrode diameters. Before another bead can be laid over an earlier bead, flux, scale, or oxidation must be removed from the earlier bead. To prevent porosity at points where you strike the arc with low hydrogen electrodes, strike the arc about one inch from the end of the previous weld increment and back-step into the crate rather than drag the arc down over the crater as you do with other electrodes. This procedure will help to insure that your weld will pass X-ray test standards. The preferred method of back-gouging is arc-air gouging, followed by clean-up grinding. The use of proper air pressure and current generally minimizes carbon deposits. However, if back gouging is done improperly, troublesome carbon deposits may be left in the joint. Grinding to one-sixteenth of an inch below the exposed surface will normally remove the carbon deposits.

CAUTION

Do not use an oxyacetylene torch to remove carbon deposits. There is danger of overheating, which may cause an unsatisfactory joint.

Table 2-2. Current-Voltage Settings

Electrode size	Current (amperes)	Voltage
1/8 x 14	140	22
3/32 x 14	200	22
3/16 x 14	250	24
7/32 x 18	300	24

Table 2-3. Suggested Minimum (1) And Maximum Preheat Temperatures For "T-1" Steel

Plate thickness (inches)	Manual metal arc process	Inert-gas metal-arc process (2)	Submerged arc process	
			Alloy wire neutral flux (3)	Carbon steel wire alloy flux (4)
Between 1 and 2"	150	150	200	300

(1) A preheat temperature above the minimum shown may be required for highly restrained welds. However, preheat or interpass temperature should never exceed 400°F for steels through 1½ inch, and 450°F above 1½ inch.

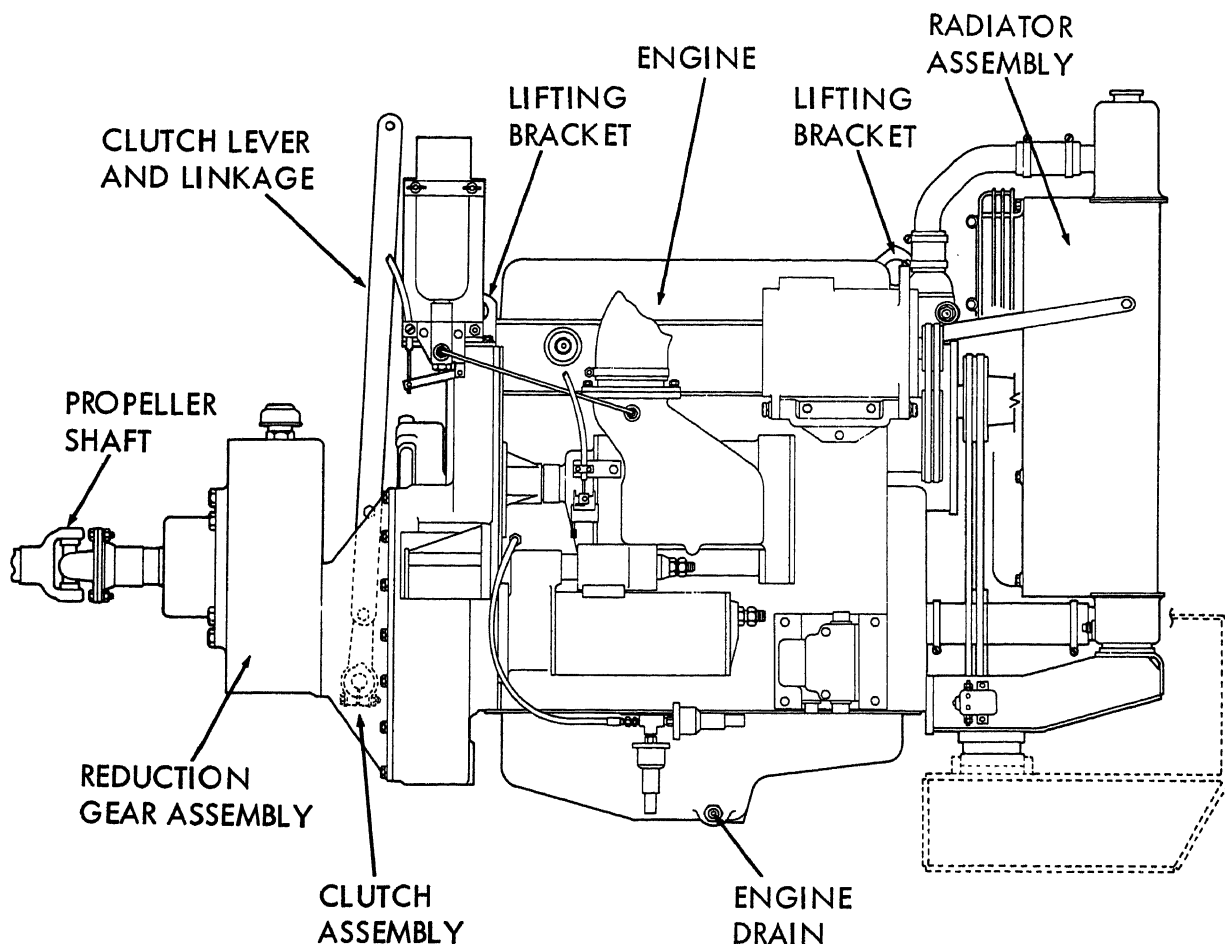
(2) Example: Airco A-632 wire and argon with 1 percent oxygen

(3) Example: Linde Oxweld 100 wire and 709-5 flux

(4) Example: Lincoln L61 wire and A0905 X 10 flux

2-10. Engine and Reduction Gear Assembly

a. *General.* The engine and reduction gear assembly (fig. 2-2), are difficult to separate or remove from the crane except as a single unit. In addition, the unit also includes the radiator, and starting aid.



TA033145

Figure 2-2. Engine and reduction gear assembly, removal and installation.

b. Removal.

(1) Refer to TM 5-3810-295-12 and remove the muffler, air cleaner hose, battery connections, control linkages, indicator lines, and electrical wiring between the engine and operator panel. Tag all leads and wires.

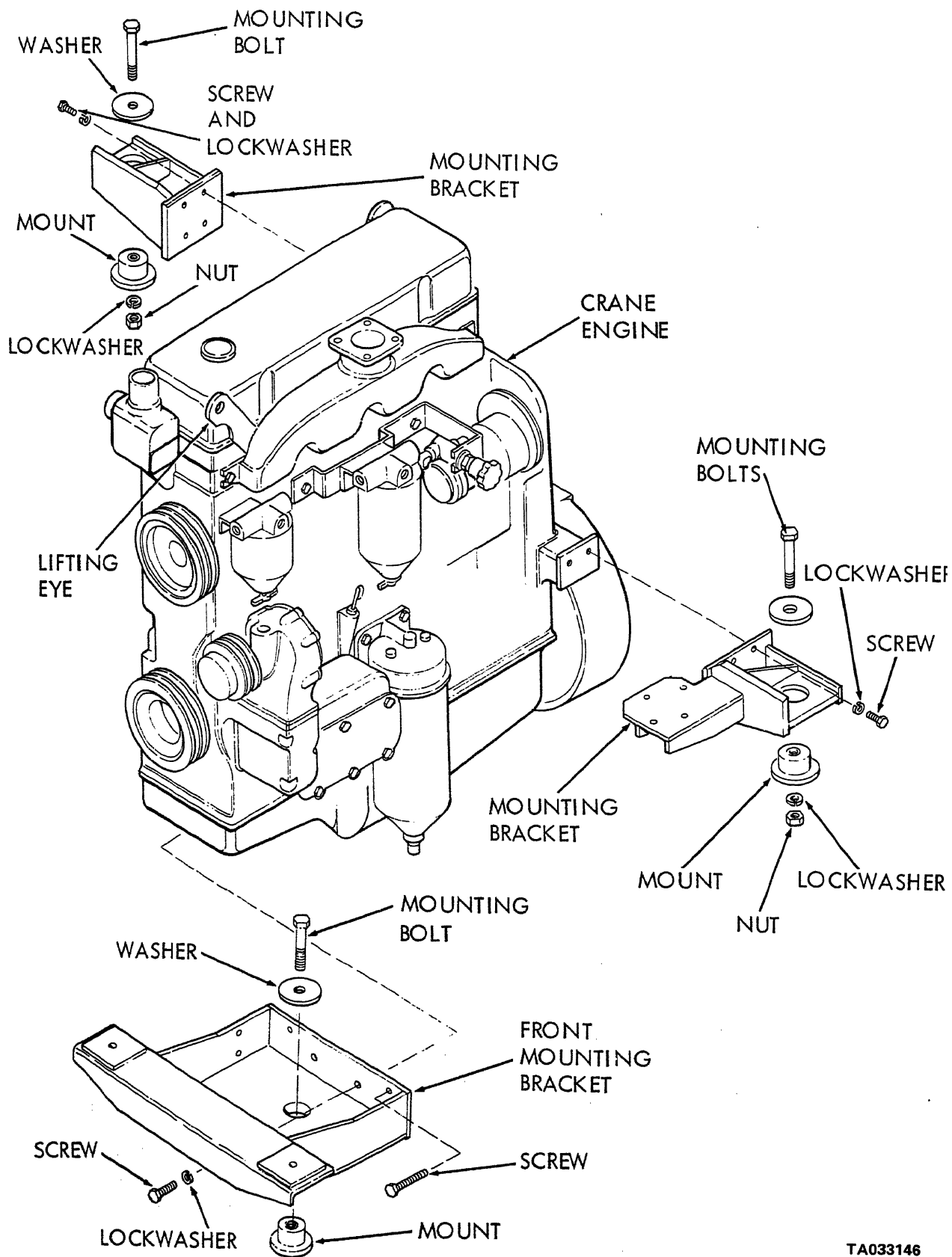
(2) Refer to figure 2-1 and remove the sheet metal and covers enclosing the engine and reduction gear assembly.

(3) Disconnect the clutch lever and linkage. Disconnect the propeller shaft from the reduction gear.

(4) Drain and disconnect fuel lines at the fuel pump. Cap the fuel lines immediately. Drain engine lubricating oil and cooling system.

(5) Refer to TM 5-3810-295-12 and remove the tachometer cable from the engine.

(6) Refer to figure 2-2, and attach a suitable sling and lifting device to the engine. Remove engine mounting bolts (fig. 2-3) and lift the engine and reduction gear and clutch assembly from the crane.



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Figure 2-3. Crane engine mounting.

c. Installation.

(1) Refer to figure 2-2 and attach a suitable sling and lifting device to the engine lifting brackets.

(2) Place the engine and reduction gear assembly on the engine mounting brackets of the revolving frame. Refer to figure 2-3 and install the mounting bolts.

(3) Refer to TM 5-3810-295-12 and perform the following operations:

(a) Connect the tachometer cable at the engine.

(b) Connect fuel lines at the fuel pump and return manifold.

(c) Connect all electrical leads and wires removed previously.

(d) Install propeller shaft. Install control linkages, battery connections, muffler, and air cleaner hose.

(4) Connect clutch linkage between the operator

controls and the clutch assembly. (fig. 2-2)

(5) Refer to figure 2-1 and install cab sheet metal and covers previously removed.

(6) Service the engine and reduction gear and clutch assembly as specified in TM 5-3810-295-12.

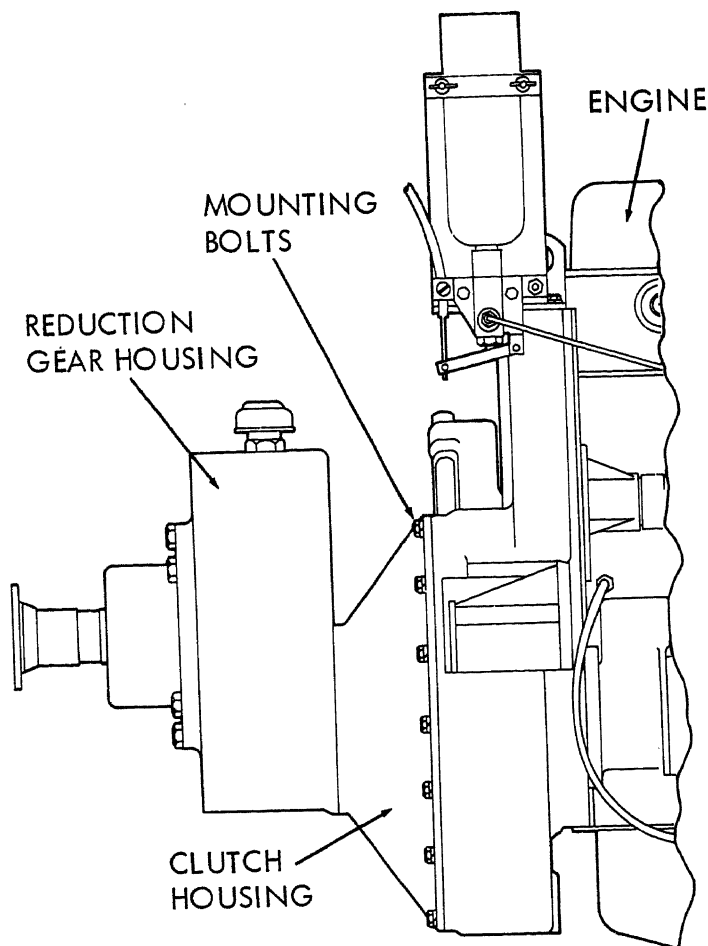
2-11. Reduction Gear and Clutch Assembly

a. General. The reduction gear and clutch assembly is removed from the crane as a unit along with the crane engine. The following procedures are for removal of the reduction gear and clutch assembly from the engine after the entire unit has been removed from the revolving frame.

b. Removal.

(1) Place the engine and reduction gear and clutch assembly on a suitable overhaul stand.

(2) Refer to figure 2-4 and remove the reduction gear and clutch assembly.



- STEP 1. BLOCK REDUCTION GEAR AND CLUTCH HOUSING. MAINTAIN ALIGNMENT WITH ENGINE.
- STEP 2. REMOVE CLUTCH HOUSING MOUNTING BOLTS AND LOCKWASHER.
- STEP 3. REMOVE REDUCTION GEAR AND CLUTCH ASSEMBLY.

TA033147

Figure 2-4. Reduction gear and clutch assembly, removal and installation.

c. Installation.

(1) Enter the reduction gear and clutch assembly on the flywheel ring gear. With the assembly properly aligned, push the throwout bearing in to hold the clutch plates in position for assembly.

(2) Refer to figure 2-4 and install the reduction gear and clutch assembly.

2-12. Rear Drumshaft Assembly

a. Removal.

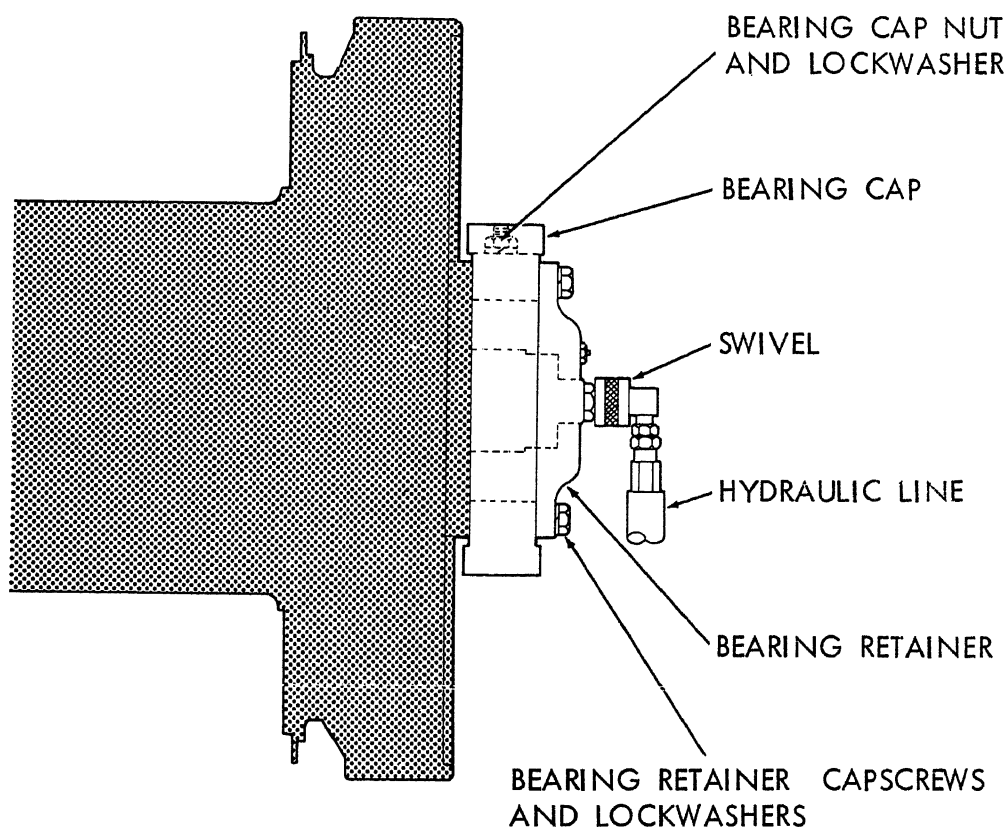
(1) Refer to TM 5-3810-295-12 and perform the following operations:

(a) Close hydraulic reservoir shut-off valve. Remove rear drumshaft drive chain case.

(b) Remove rear drum brake band.

(2) Refer to figure 2-1 and remove sheet metal required to remove rear drumshaft through roof of the cab.

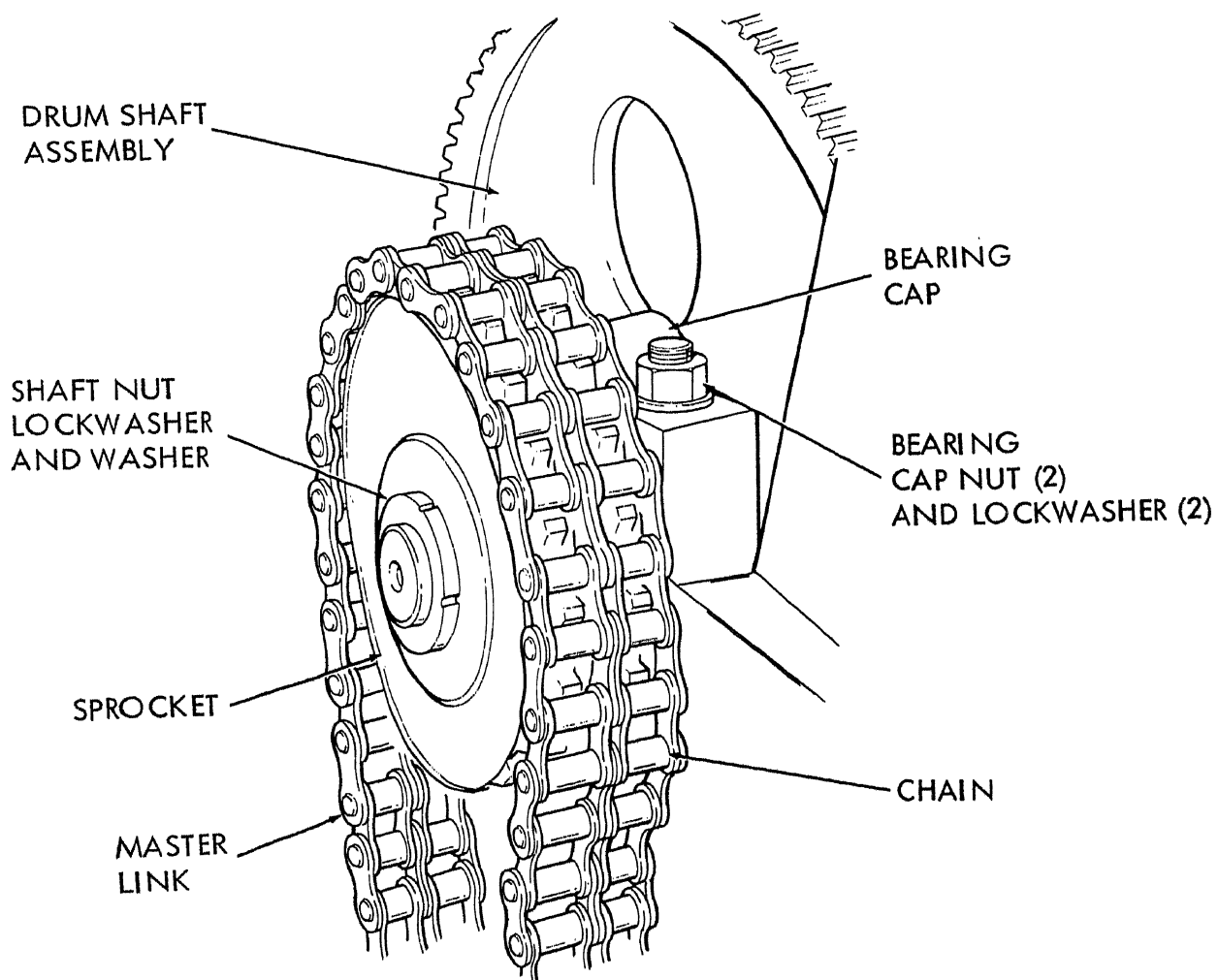
(3) Refer to figure 2-5. Remove rear drumshaft assembly.



- STEP 1. DISCONNECT HYDRAULIC LINE AND PLUG LINE.
- STEP 2. REMOVE SWIVEL.
- STEP 3. REMOVE BEARING RETAINER CAPSCREWS AND LOCKWASHERS.
- STEP 4. REMOVE BEARING RETAINER.
- STEP 5. REMOVE BEARING CAP NUTS AND LOCKWASHERS.
REMOVE BEARING CAP.

TA033148

Figure 2-5. Rear drumshaft assembly, removal and installation (sheet 1 of 2).



6. DRIVE OUT MASTER CHAIN LINK PINS. REMOVE CHAIN.
7. REMOVE SHAFT NUT, LOCKWASHER, AND WASHER.
8. SLIDE SPROCKET OFF.
9. REMOVE BEARING RETAINER CAP-SCREWS AND LOCKWASHERS (SAME AS OPPOSITE END OF SHAFT).
10. REMOVE BEARING CAP NUTS AND LOCKWASHERS. REMOVE BEARING CAP.
11. ATTACH SUITABLE LIFTING DEVICE. REMOVE DRUMSHAFT ASSEMBLY.

TA03314

Figure 2-5. Rear drumshaft assembly, removal and installation (sheet 2 of 2).

b. Installation.

(1) Refer to figure 2-5 and install rear drumshaft assembly.

(2) Refer to figure 2-1 and install sheet metal removed during disassembly.

(3) Refer to TM 5-3810-295-12 and perform the following operations:

(a) Install rear drum brake band. Install rear drumshaft drive chain case.

(b) Open hydraulic reservoir shut-off valve. Bleed hydraulic system to remove any air trapped in the hydraulic lines.

CAUTION

Be sure hydraulic fluid does not come into

contact with any brake or clutch band.

2-13. Front Drumshaft Assembly*a. Removal.*

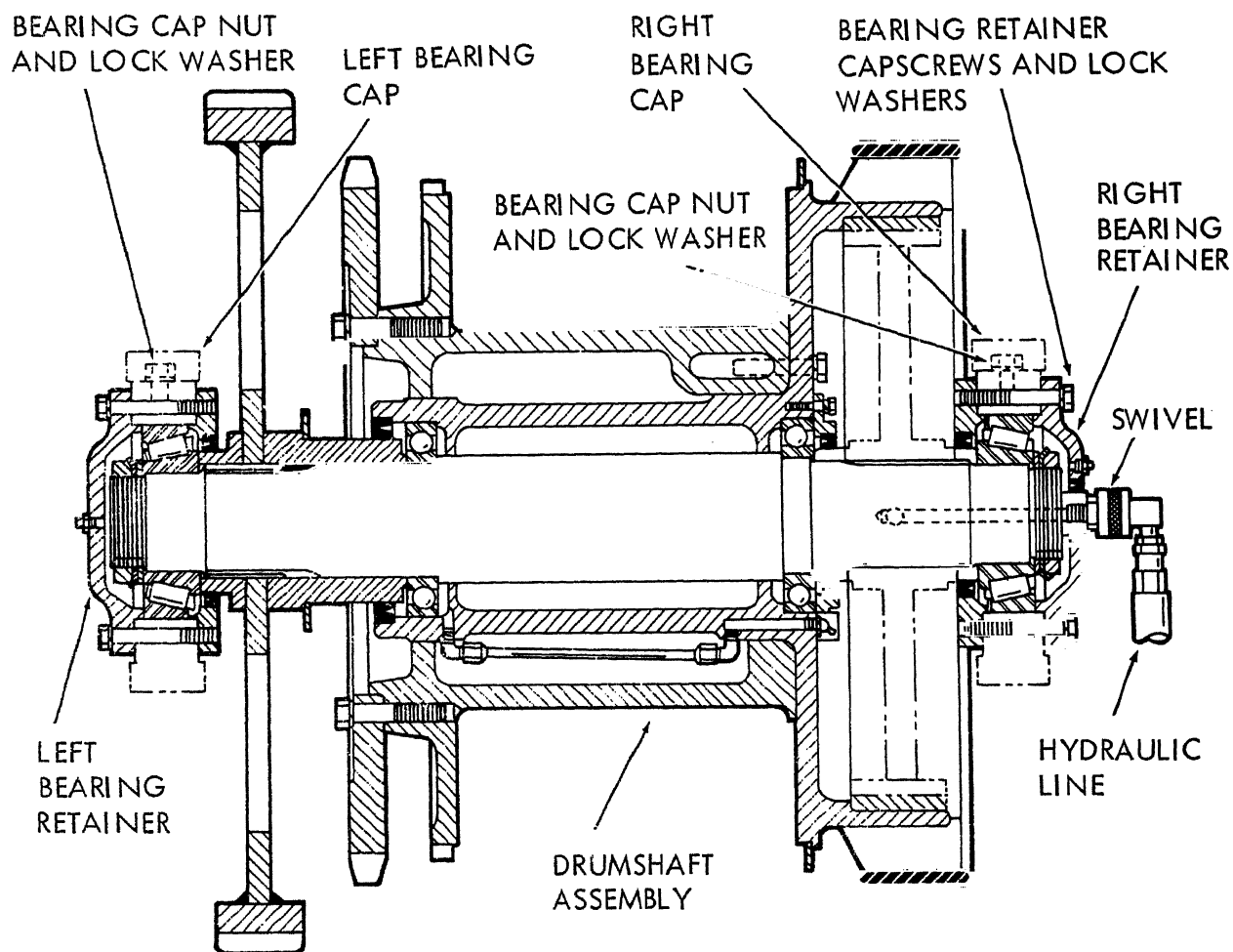
(1) Refer to TM 5-3810-295-12 and perform the following operations:

(a) Close hydraulic reservoir shut-off valve.

(b) Remove front drum brake band.

(2) Refer to figure 2-1 and remove sheet metal, as required, to allow removal of front drumshaft from the cab.

(3) Remove front drumshaft assembly in accordance with figure 2-6.



- STEP 1. DISCONNECT HYDRAULIC LINE AND PLUG LINE.
- STEP 2. REMOVE SWIVEL BY UNSCREWING FROM SHAFT ASSEMBLY.
- STEP 3. REMOVE BEARING RETAINER CAPSCREWS AND LOCKWASHERS ON SWIVEL END. REMOVE RIGHT BEARING RETAINER.
- STEP 4. REMOVE BEARING CAP NUTS AND LOCK WASHERS ON RIGHT SIDE. REMOVE BEARING CAP.
- STEP 5. REMOVE BEARING RETAINER CAPSCREWS AND LOCKWASHERS ON LEFT SIDE. REMOVE LEFT BEARING RETAINER.
- STEP 6. REMOVE BEARING CAP NUTS AND LOCK WASHERS ON LEFT END. REMOVE BEARING CAP.
- STEP 7. REMOVE DRUM SHAFT ASSEMBLY.

TA033150

Figure 2-6. Front drumshaft assembly, removal and installation

b. Installation.

(1) Refer to figure 2-6 and install front drumshaft assembly.

(2) Refer to TM 5-3810-295-12 and perform the following operations:

(a) Install front drum brake band.

(b) Open hydraulic reservoir shut-off valve. Bleed hydraulic line to the front drum assembly.

CAUTION

Be sure hydraulic fluid does not come into

contact with any brake or clutch band.

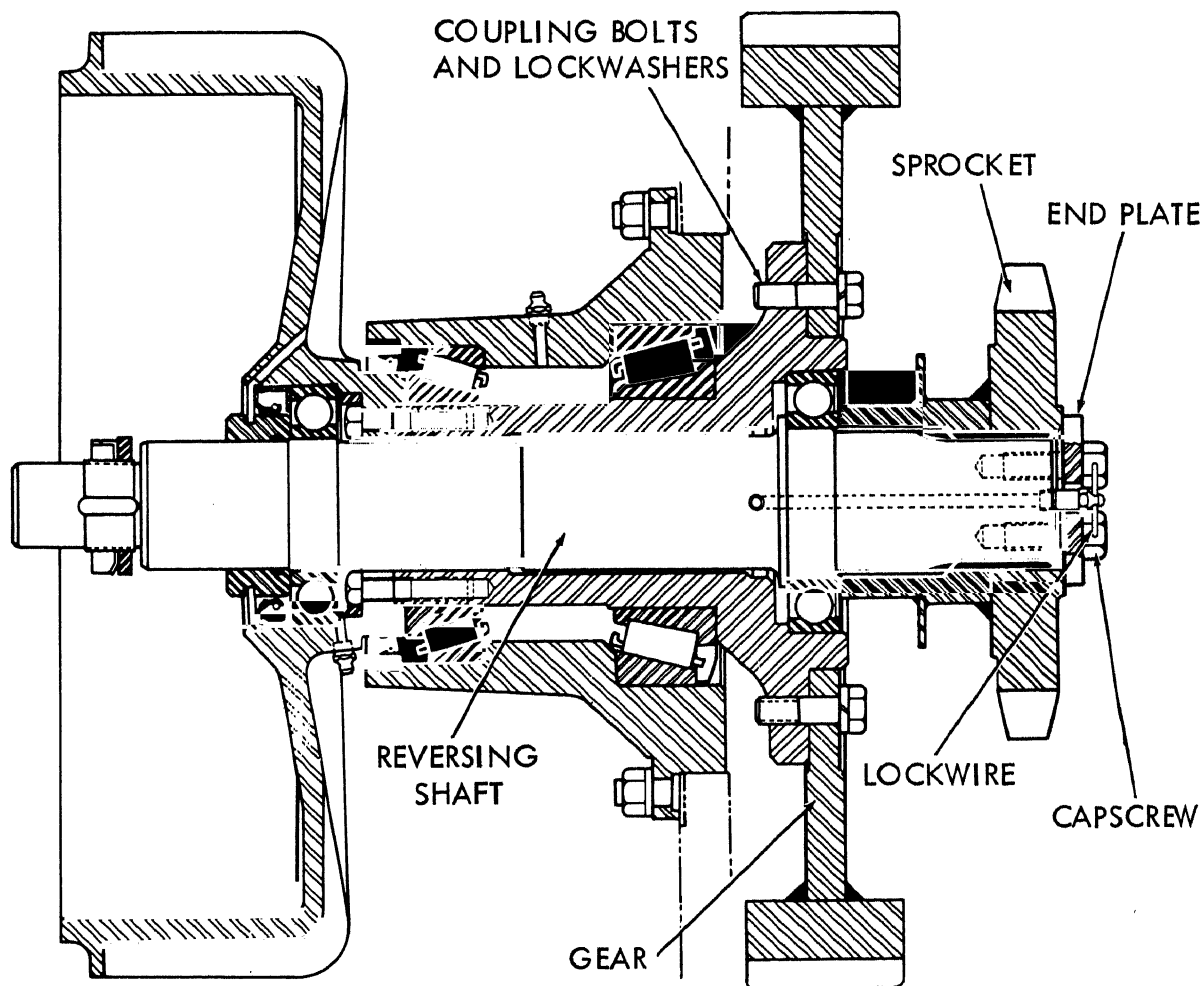
2-14. Reversing Shaft Assembly**a. Removal.**

(1) Refer to TM 5-3810-295-12 and perform the following operations:

(a) Close hydraulic reservoir shut-off valve.

(b) Remove reversing shaft chain tension by adjusting the reversing shaft chain idler.

(c) Refer to figure 2-7. Remove the reversing shaft assembly. Lift chain from sprocket.



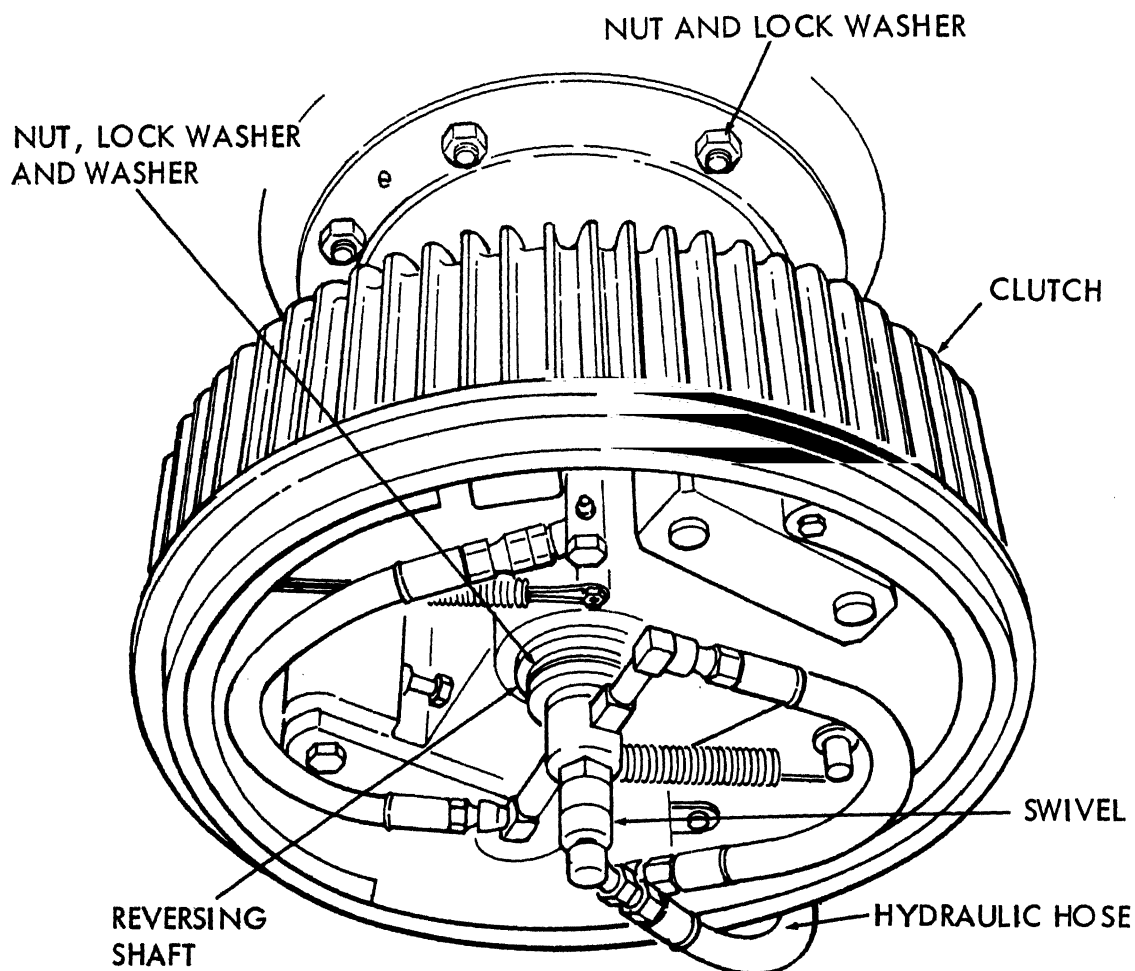
STEP 1. BREAK LOCKWIRE AND REMOVE END PLATE BY REMOVING ATTACHING CAPSCREWS.

STEP 2. REMOVE SPROCKET.

STEP 3. REMOVE GEAR BY REMOVING ATTACHING COUPLING BOLTS.

TA033151

Figure 2-7. Reversing shaft assembly, removal and installation (sheet 1 of 2).

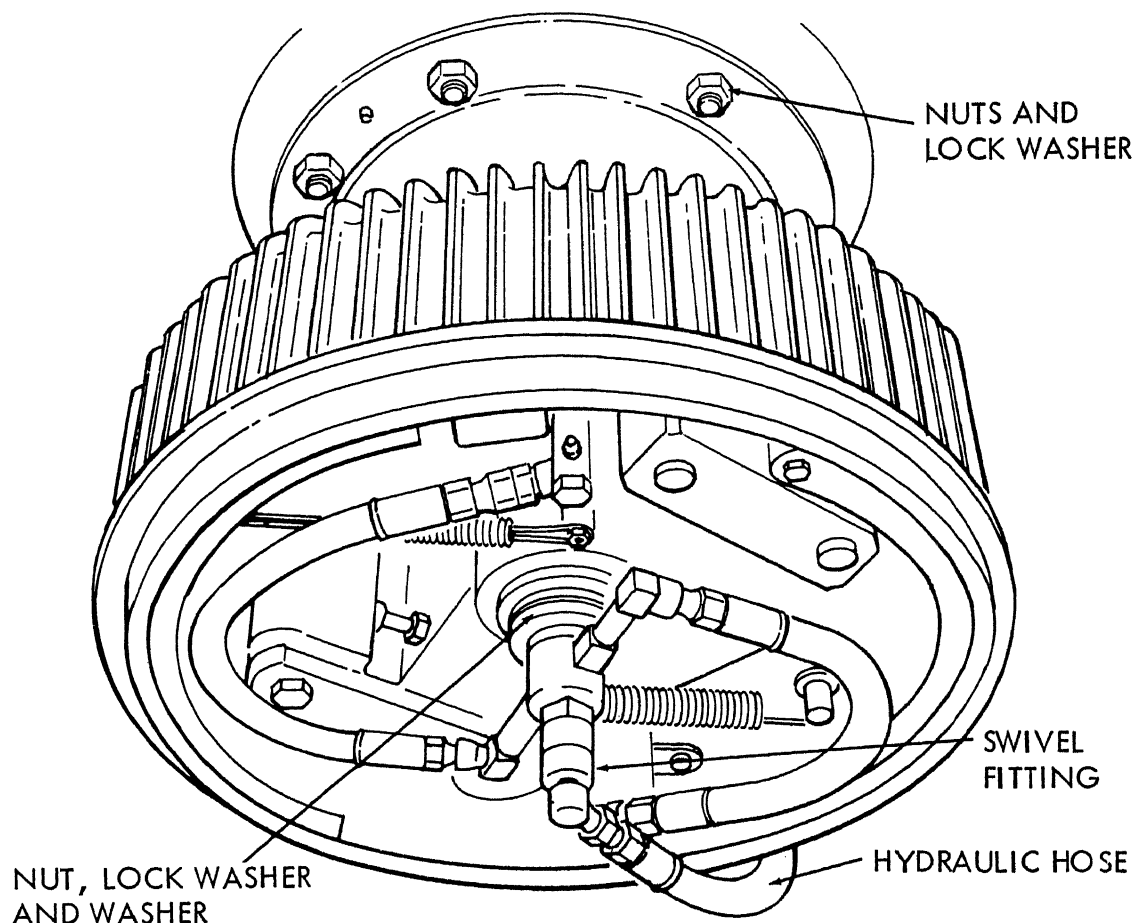


- STEP 4. DISCONNECT HYDRAULIC HOSE AT SWIVEL. PLUG HOSE AND SHAFT HOLE.
- STEP 5. REMOVE SWIVEL BY UNSCREWING FROM SHAFT ASSEMBLY.
- STEP 6. REMOVE NUT, LOCKWASHER AND WASHER FROM SHAFT ASSEMBLY.
- STEP 7. REMOVE CLUTCH AS A UNIT.
- STEP 8. SUPPORT ASSEMBLY USING A SUITABLE LIFTING DEVICE. REMOVE NUTS AND LOCK WASHERS. USING A SUITABLE PULLER REMOVE REVERSING SHAFT.

TA033152

Figure 2-7. Reversing shaft assembly, removal and installation (sheet 2 of 2).

NOTE: INSTALLED BACKLASH IS 0.008 INCH.
END PLAY IS 0.003 TO 0.005 INCH.



- STEP 1. DISCONNECT HYDRAULIC HOSE AT SWIVEL. PLUG HOSE AND SHAFT HOLE IMMEDIATELY.
- STEP 2. REMOVE SWIVEL BY UNSCREWING FROM SHAFT.
- STEP 3. REMOVE CLUTCH MOUNTING NUTS, LOCKWASHERS, AND WASHERS. REMOVE CLUTCH AS A UNIT.
- STEP 4. SUPPORT ASSEMBLY WITH A SUITABLE LIFTING DEVICE. REMOVE SHAFT NUTS AND LOCK WASHERS.
- STEP 5. REMOVE HORIZONTAL SWING SHAFT ASSEMBLY.

TA033153

Figure 2-8. Horizontal swing shaft assembly, removal and installation.

b. Installation.

- (1) Refer to figure 2-7 and install reversing shaft.
- (2) Refer to TM 5-3810-295-12 and perform the following operations:
 - (a) Install reversing shaft chain and adjust chain tension by means of the chain idler.
 - (b) Open hydraulic reservoir shut-off valve. Bleed hydraulic line to the reversing shaft.

2-15. Horizontal Swing Shaft Assemblies

a. General. Two horizontal swing shafts are used. Each shaft drives the upper in one direction only. The left shaft drives the upper to the right. The right shaft drives the upper to the left. Be sure the correct shaft is removed in the event of swing system malfunction.

b. Removal.

- (1) Refer to TM 5-3810-295-12 and perform the

following operations:

(a) Close hydraulic reservoir shut-off valve.

(b) Loosen horizontal swing shaft drive chain tension.

(c) Remove cover plate which allows access to the horizontal swing shaft drive chains and lift the chain off the swing drive sprocket.

Paragraph 2-16. Worm Shaft Assembly Deleted.

Figure 2-9. Deleted.

Paragraph 2-17. Boom Hoist Shaft
Deleted.

Paragraph 2-18. Vertical Swing Shaft
Deleted.

Paragraph 2-19. Swing Brake Shaft
Deleted.

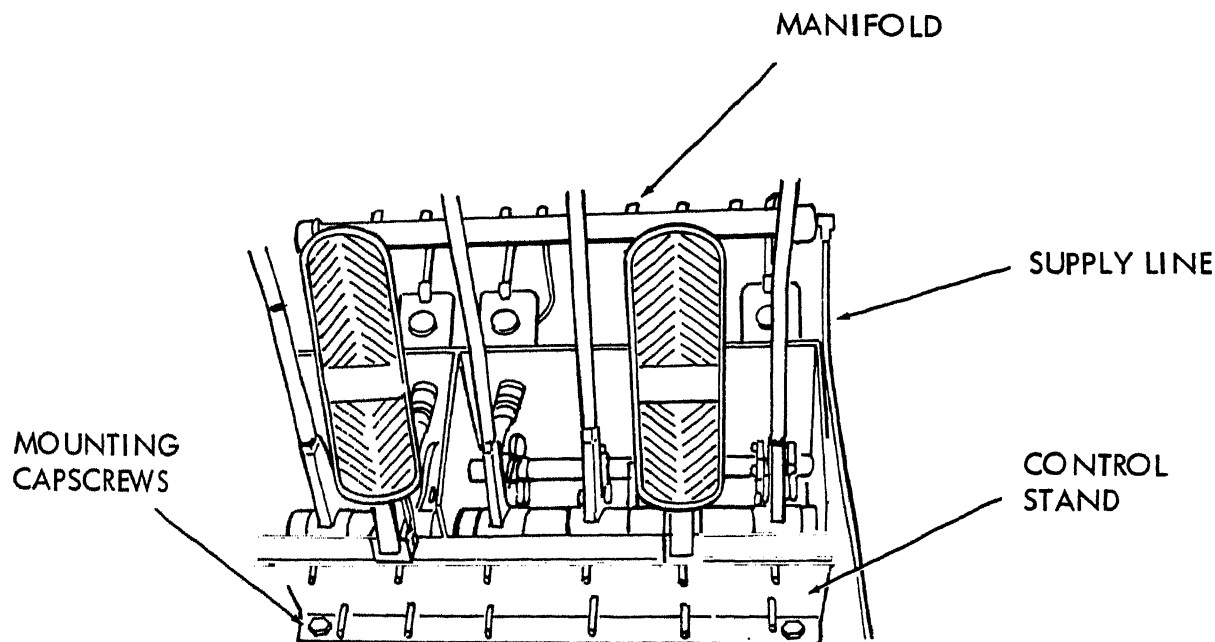
Figures 2-10 through 2-13. Deleted.

Figure 2-14 deleted.

2-20. Control Stand Assembly

a. Removal.

- (1) Refer to TM 5-3810-295-12 and shut off the hydraulic oil supply to the control stand assembly.
- (2) Refer to figure 2-1 and remove plates and floor plates as required to expose the control stand assembly.
- (3) Refer to figure 2-15 and remove the control stand assembly.



- STEP 1. DISCONNECT SUPPLY LINE AT MANIFOLD AND ALL MASTER CYLINDER OUTPUT LINES. PLUG LINES.
- STEP 2. REMOVE MOUNTING CAPSCREWS.
- STEP 3. REMOVE CONTROL STAND.

TA033160

Figure 2-15. Control stand assembly, removal and installation.

b. Installation.

(1) Refer to figure 2-15 and install the control stand assembly.

(2) Refer to TM 5-3810-295-12 and open the hydraulic reservoir shut-off valve, replenish hydraulic oil

in the reservoir, if necessary, and bleed the air from the control stand assembly.

(3) Refer to figure 2-1 and TM 5-3810-295-12 and reinstall deck plates and sheet metal as required.

CHAPTER 3

REPAIR OF CRANE ENGINE ACCESSORIES

Section I. REPAIR OF GENERATOR

3-1. Description

The engine generator is a belt-driven, 28-volt, 60-amp alternator with enclosed regulator and rectifiers.

3-2. Removal

Refer to TM 5-3810-295-12 and remove the generator from the engine.

3-3. Disassembly

a. Refer to figure 3-1 and remove pulley nut (1), washer (2), pulley spacer (3), Woodruff key (4) and fan (5).

b. Remove screws (6) and retainer (7). Remove bearing seal (8), bearing spacer (9), and packing (10) and (11). Remove screws (13) and guard washers (14).

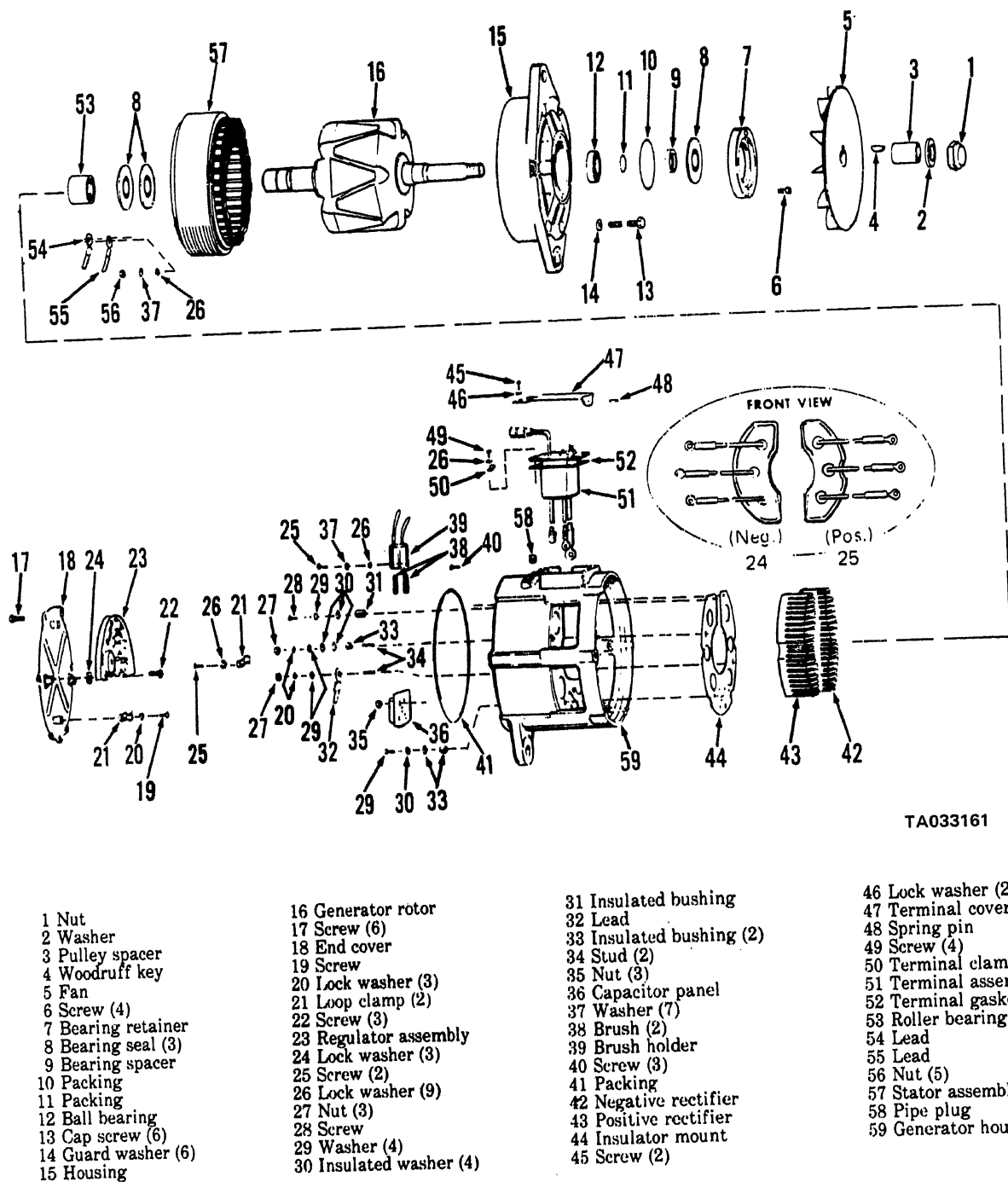
c. Remove housing (15) and bearing (12). Drive end housing (15) may be freed from the stator by tapping lightly with a fiber mallet.

NOTE

When drive end housing has been removed, the stator windings are exposed. Use extreme care to avoid nicks or other damage to the stator windings. Do not rest alternator on exposed windings unless suitable protection is provided.

d. Remove rotor (16) from the stator.

e. Remove screws (17) and lift end plate cover (18) and regulator assembly (23) clear of the alternator. Pull leads from the regulator.



TA033161

Figure 3-1. Generator assembly—exploded view.

f. Remove screw (19), lock washer (20) and loop clamp (21) from the end plate cover. Remove screws (22), regulator (23) and lock washers (24).

g. Remove screw (25), lock washer (26) and loop clamp (21). Remove nut (27), screw (28), washers (29) and (20), insulated washers (30), insulated bushing (31), lead (32), insulated bushing (33), and studs (34).

h. Remove capacitor panel (36) by removing nuts

(35). Remove brushes (38) and brush holder (39) by removing screw (25), washer (37) and lock washer (26).

i. Remove screws (40), washers (29) and insulated washer (30), and insulated bushing (33). Remove packing (41).

j. Remove rectifiers (42) and (43) from insulator mount (44).

k. Remove screws (45), lock washers (46) and lift ter-

minal cover (47) from terminal assembly (51). Remove spring pin (48).

l. Remove screws (49), lock washers (26) and terminal clamp (50) from the terminal assembly. Carefully lift terminal assembly (51) from the generator housing, along with gasket (52).

m. Remove roller bearing (53) from housing (59) and leads (54) and (55). Remove nuts (56), washers (37) and lock washers (26) from stator assembly (57). Pull stator assembly (57) from the housing.

n. Remove pipe plug (58) from housing (59).

3-4. Inspection and Repair

a. Clean all parts in cleaning solvent, Federal Specification P-S-661, before inspecting. Clean all nonelectrical parts in cleaning solvent, Federal Specification P-D-680. Dry all parts with compressed air.

b. Inspect all parts for visible signs of mechanical damage due to wear, cracks, etc. Check all varnish and epoxy-coated parts for bare spots and recoat if necessary.

c. Check rotor for wear on bearing surfaces.

d. Replace all packings, seals and gaskets.

e. Replace brushes if they are worn more than one-half of their original length.

f. Test the regulator assembly by substituting it in an alternator known to be in good condition. Replace the regulator if it does not operate satisfactorily.

g. The stator should be checked for continuity as follows. Connect an ohmmeter between each pair of terminals. The meter should indicate a very low resistance. If a low reading is not obtained, the stator windings are open and the stator should be replaced. A ground test should also be made by connecting the ohmmeter between each stator terminal and the stator core. If a reading is obtained, the stator is grounded and must be replaced.

NOTE

Diode leads must be disconnected from the stator terminals during this test.

3-5. Reassembly

a. Refer to figure 3-1. Grease bearing (53) and press the bearing into housing (59).

b. Install terminal and capacitor assembly (51) on housing (59) with gasket (52) in place. Install terminal clamp (50) and secure the assembly with screws (49)

and lock washers (26).

c. Install insulated mount (44) and rectifiers (42) and (43). Be sure polarities of the rectifiers are in proper position, according to markings on the housing.

d. Secure capacitor leads to the rectifiers with screws (40), washers (29), insulated washers (30) and insulated bushing (33). Install capacitor panel (36) and secure with nuts (35).

e. Install spring pin (48) and cover (47) and secure with screws (49) and lock washers (46).

f. Install seals (8) with lips of the seals pointed towards the rotor. After seals are pressed in place, apply a small amount of sealant such as Loctite around the outer edges of the seals.

g. Install lock washers (26), washers (37), leads (54) and (55), and secure with nuts (56). Install stator (57) into housing (59). Be sure housing is free of dirt and grit to avoid damage to the stator windings.

h. Install screw (28), nut (27), lock washer (20), washers (29), insulated washers (30), insulated bushing (31), lead (32) and studs (34). Install brushes (38) and brush holders (39) and secure into position with screws (25), washers (37) and lock washers (26).

i. Install loop clamp (21) and secure with screw (25) and lock washer (26). Install second loop clamp (21) to end cover (18) and secure with screw (19) and lock washer (20). Install regulator (23) and secure with screws (22) and lock washers (24).

j. Install packing (41) and end cover (18) and secure with screws (17).

k. Grease bearing (12) and press the bearing and shaft of rotor (16) into drive end housing (15). Slide rotor assembly into housing and stator.

l. Secure drive end housing with screws (13) and washers (14). Install packing (10) and (11), bearing spacer (9). Press seal (8) into position with seal lip pointed toward pulley end of the shaft.

m. Install bearing retainer (7) and secure the retainer with screws (6).

n. Slide fan (5) into position on the shaft and install Woodruff key (4) into position between the shaft and fan. Install pulley spacer (3), washer (2) and nut (1). Do not hold fan when nut (1) is tightened.

3-6. Installation

Refer to TM 5-3810-295-12 and install the generator on the crane engine.

Section II. REPAIR OF ENGINE STARTING MOTOR

3-7. Description

The starting motor, through the engine ring gear, cranks the engine until it starts. The starting motor automatically disengages from the ring gear when the engine starts.

3-8. Removal

Remove the engine starting motor according to instructions given in TM 5-3810-295-12.

3-9. Disassembly

a. Refer to figure 3-2. Screws (1) and lock washers

(2) are removed during removal procedures. Note the relative positions of solenoid (36), lever housing (59) and drive housing (40) so these items can be reinstalled in the same position.

b. Remove nuts (3) and (4), lock washers (5), and washer (6). Remove screws (7) and lock washers (8), and end bell (9). Remove pipe plug (10) and oil wick (11), and expansion plug (12), plug gasket (13) and felt plug (14) from the end bell.

c. Remove insulated washers (15) from the terminals. Remove screws (16) and lift brushes (17) from the brush holders.

d. Remove screw and lock washer (18) and lift plate assembly (19) from the end bell. Remove brush hold down springs (23) from the plate assembly by removing screws (20), lock washers (21) and washers (22). Remove electrical lead (24) from the assembly.

e. Remove inspection plug (25), plug gasket (26) and adjusting plunger nut (27) from the lever housing. Then remove retaining ring (28), spring retainer (29), spring (30), spring retainer (31), plunger boot (32) spring retainer washer (33) and boot clamp (34) from the lever housing.

f. Remove screws and lock washers (35) and lift solenoid (36) from the housing. Slide plunger (37) from

the lever housing.

g. Remove screws (38) and (39) and separate drive housing (40) from lever housing (59). Remove pipe plug (41) and felt wick (42) from the drive housing. Remove expansion plug (43), gasket (44) and felt plug (45) from the housing.

h. If necessary, press sleeve bearing (46) from the drive housing.

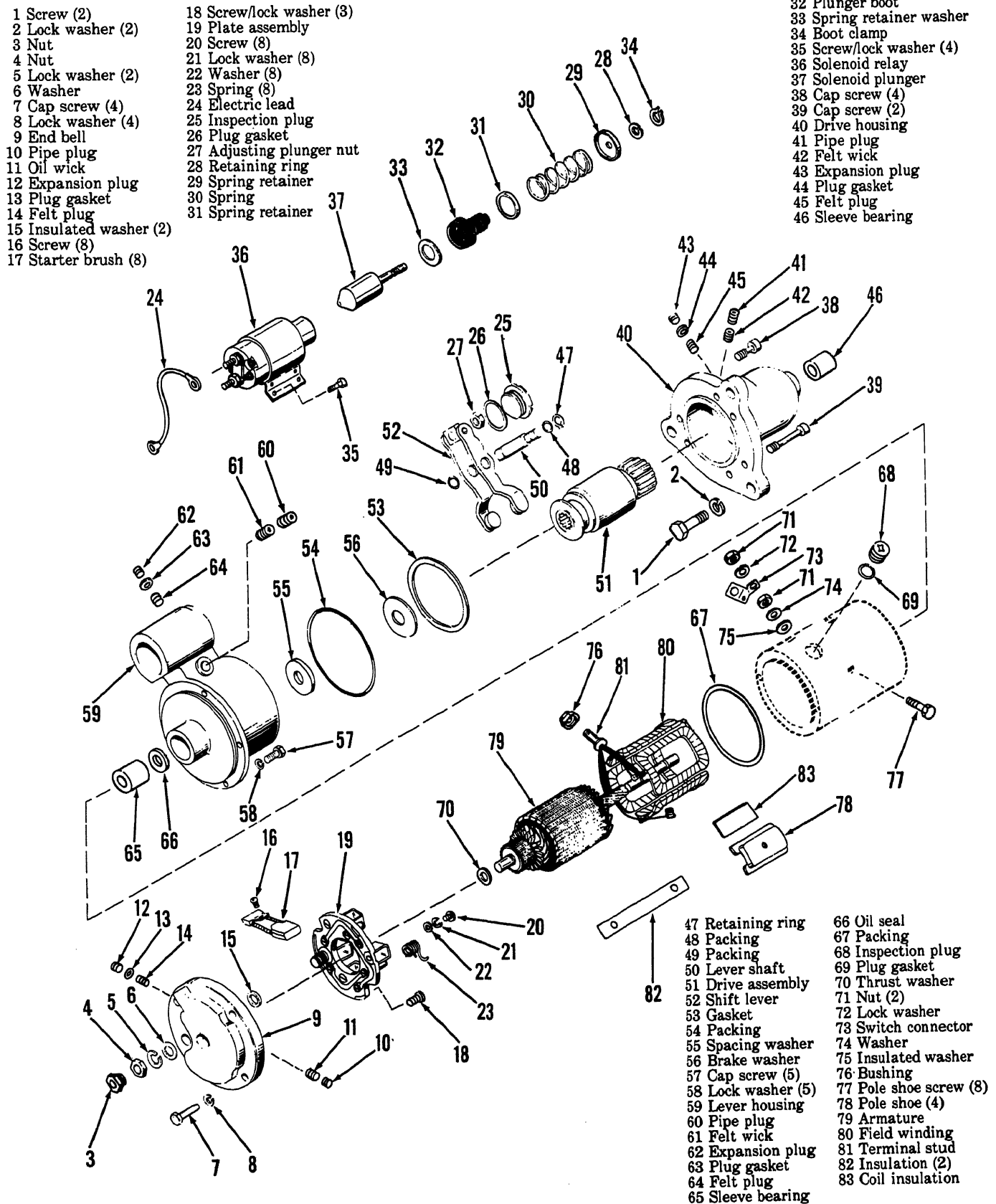
i. Remove retaining ring (47) from lever shaft (50), and remove packing (48) and (49), and slide shaft (50) from lever (52).

j. Slide drive assembly (51) from the armature shaft. Lever (52) can now be removed from the lever housing.

k. Remove gasket (53) and packing (54) from lever housing (59). Remove spacer washer (55) and brake washer (56) from the armature shaft.

l. Remove capscrews (57) and lock washers (58) and separate lever housing (59) from the generator assembly. Remove pipe plug (60) and felt wick (61) from the lever housing, and remove expansion plug (62), plug gasket (63) and felt plug (64).

m. Remove sleeve bearing (65) and oil seal (66) from the lever housing. Remove packing (67) from the generator housing and remove inspection plug (68) and gasket (69).



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Figure 3-2. Starting motor assembly—exploded view.

n. Remove thrust washer (70) from the armature assembly. Remove nuts (71), lockwasher (72), switch connector (73), washer (74), insulated washer (75) and bushing (76) from the generator housing.

a. Slide armature (79) from the field windings, taking care to avoid damaging the windings and insulation.

p. Remove pole shoe screws (77) with a pole shoe screwdriver. Remove pole shoes (78) using a spreader, and remove field wing (80) being careful not to distort the winding frame.

q. Remove terminal stud (81), insulation (82) and coil insulation (83).

3-10. Inspection and Repair

a. Clean all parts, except the drive assembly (51) with dry cleaning solvent, Federal Specification P-S-661, and dry the parts with compressed air. Clean the drive unit with a clean cloth.

b. Clean the commutator with No. 00 sandpaper.

CAUTION

Do not clean the drive, armature or field coils in a degreasing tank or with grease dissolving solvents. These would dissolve the lubricants and damage the insulation.

c. Replace all seals, gaskets and packings.

d. Check all housings for cracks or damage. Check all sealing surfaces for cracks, pitting or rough spots. Replace any damaged parts.

e. Check the commutator end frame, and replace if it is cracked or distorted.

f. Check the armature bearing surfaces and replace the armature if these are worn. The commutator may be turned on a lathe if it is out of round, worn, or has high insulation. After turning, undercut the insulation to $\frac{1}{32}$ -inch wide and deep. Lightly sand the commutator with No. 00 sandpaper and remove all copper and insulation dust with compressed air.

g. Check the commutator for opens, shorts and ground with a growler or test lamp.

h. Check the field coil with a test lamp and replace the windings if the tests indicate opens or shorts.

i. Replace brushes that are cracked or worn beyond half their original length. Check the solenoid springs and boot for indications of deterioration or wear.

j. Check drive assembly (51) for wear, or cracks, especially at the roots of the gear teeth.

3-11. Reassembly

a. Refer to figure 3-2. Install bushing (76) on terminal stud (81) and carefully install field winding (80) into the generator housing. Install insulation (82) and (83) between the coil and frame.

b. Set pole shoes (78) in place and secure the shoes with pole shoe screws (77), using a pole shoe screwdriver.

c. Install insulated washer (75), washer (74), nuts (71), switch connector (73) and lock washer (72) on the terminal stud.

d. Install oil seal (66) into hub of lever housing (59) and press sleeve bearings (65) and (46) into their respective housings.

e. Install lever housing (59) on generator frame and secure with screws (57) and lock washers (58). Install armature (79) into the field frame and lever housing.

f. Install spacing washer (55) and brake washer (56) on the armature shaft. Place lever (52) on drive assembly (51) and install the assembly on the armature shaft and into the lever housing.

g. Insert lever shaft (50) through the lever housing and lever, install packings (48) and (49), and secure the lever with retaining ring (47).

h. Install packing (54) and gasket (53) and install drive housing (40) on lever housing (59). Secure the drive housing with screws (38) and (39).

i. Insert plunger (37) through lever (52), and install spring retainer washer (33), plunger boot (32), spring retainer (31), spring (30), spring retaining (29), clamp (34) and secure the assembly with retaining ring (28). Install adjusting nut (27), plug gasket (26) and inspection plug (25).

j. Install solenoid (36) and secure with screw and lock washer (35).

k. Install brush springs (23) on plate (19) and secure the springs with washers (22), lock washers (21) and screws (20). Install brushes (17) and secure with screws (16).

l. Install insulated washers (15) on the plate assembly studs and mount plate (19) on end bell (9). Secure plate (19) with screw and lock washer (18).

m. Install thrust washer (70) on the end of the armature, and install end bell (9) on the frame. Secure the end bell with screws (7) and lock washers (8).

n. Install electrical lead (24), and install washer (6), lock washers (5), and nuts (4) and (3).

o. Saturate oil wicks (42), (61), and felt plugs (14), (45), and (64) with oil and install the wicks and plugs in their respective positions as shown. Secure the wicks and plugs with gaskets and plugs as shown. Install inspection plug (68) and gasket (69).

p. Check the drive pinion clearance as outlined in the following:

(1) Disconnect the field coil connection from the solenoid. Connect a battery of the same voltage as the solenoid, to the solenoid switch terminal and to the solenoid frame or ground terminal.

(2) Momentarily flash a jumper from the solenoid motor terminal to the solenoid frame or ground terminal. This places the starter drive into cranking position.

(3) With a feeler gage measure the clearance between the drive assembly (51) and sleeve drive bearing (46). Adjust clearance with adjusting plunger nut (27) to a value of 0.010-0.140 inch.

3-12. Installation

Refer to TM 5-3810-295-12 for procedures on installing the starting motor.

Section III. REPAIR OF RADIATOR

3-13. Description

The radiator consists of the radiator cores, hoses, clamps, shroud, and fan guard necessary to exchange heat to the atmosphere via the engine coolant and the radiator cores.

3-14. Removal

Refer to TM 5-3810-295-12 and remove radiator from the engine assembly.

3-15. Disassembly

Disassemble the radiator as shown in figure 3-3.

3-16. Inspection and Repair

a. Flush the inside of the radiator with approved solvent. To avoid damage to the cores, do not use high

pressure.

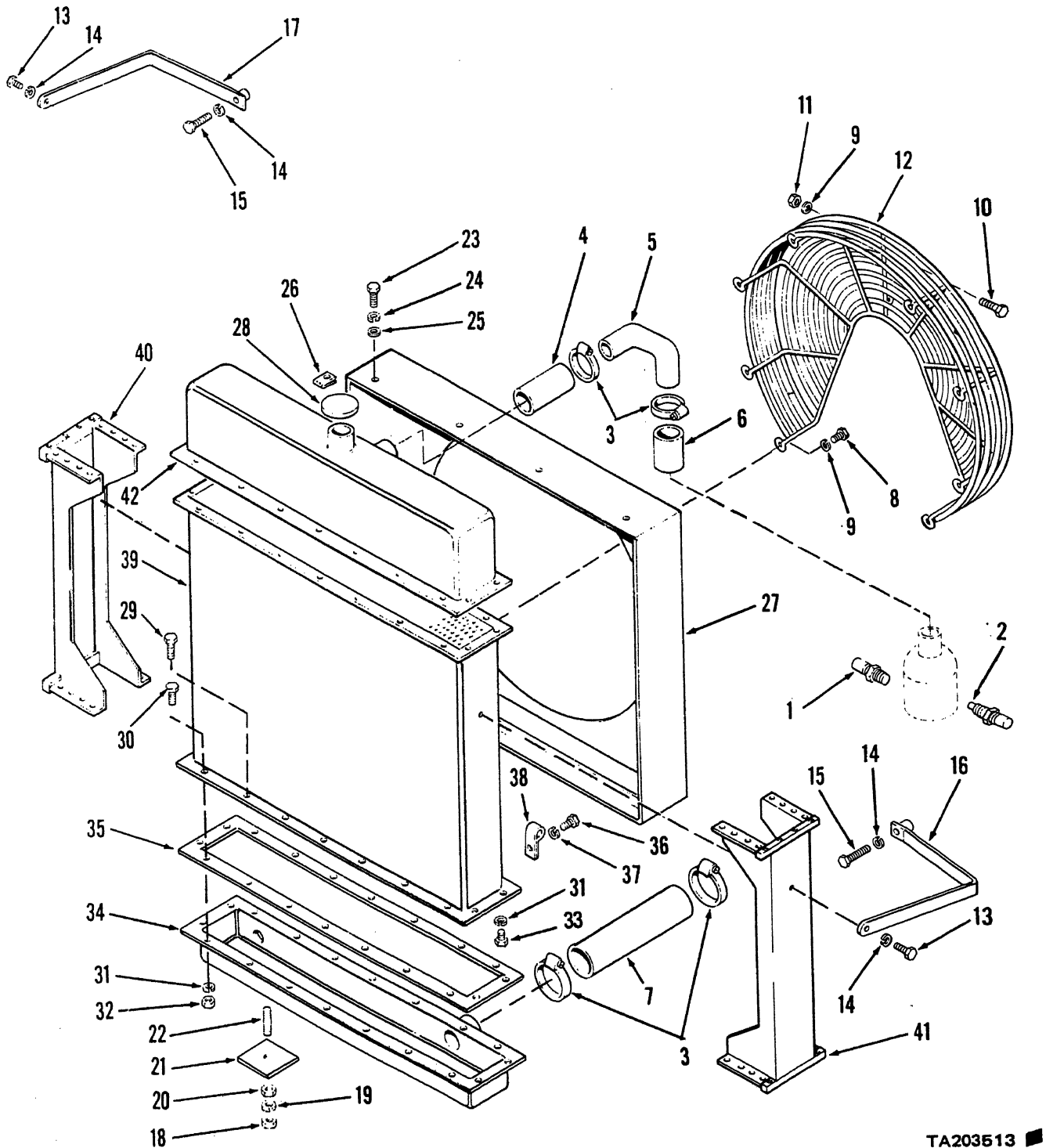
b. Clean the outside of the radiator core with compressed air, steam, or water under pressure from the fan side of the radiator.

c. Clear the overflow tube with compressed air.

d. Plug all openings and, using a suitable adaptor, connect an air hose to the radiator outlet pipe. Submerge the radiator in a tank of water and apply 50 psi pressure. Check for leaks and mark them.

e. Repair leaks using soft solder (34 to 35 percent tin and 55 to 65 percent lead). Use zinc chloride or resin flux. Flush radiator with water after soldering.

f. Straighten bent or damaged fins that could restrict air flow.



TA203513

- 1 Thermostat switch
- 2 Temperature transmitter
- 3 Hose clamp (6)
- 4 Hose
- 5 Tube
- 6 Hose
- 7 Hose
- 8 Cap screw (8)
- 9 Lock washer (12)
- 10 Cap screw (2)
- 11 Nut (2)

- 12 Fan guard
- 13 Cap screw (2)
- 14 Lock washer (4)
- 15 Cap screw (2)
- 16 Brace (right hand)
- 17 Brace (left hand)
- 18 Nut (2)
- 19 Lock washer (2)
- 20 Jam nut (2)
- 21 Pad (2)

- 22 Stud (2)
- 23 Cap screw (8)
- 24 Lock washer (8)
- 25 Flat washer (8)
- 26 Shroud clip (8)
- 27 Radiator shroud
- 28 Radiator cap
- 29 Cap screw (24)
- 30 Cap screw (32)
- 31 Lock washer (72)

- 32 Nut (56)
- 33 Cap screw (16)
- 34 Lower tank
- 35 Core washer
- 36 Cap screw (2)
- 37 Lock washer (2)
- 38 Overflow tube clamp (2)
- 39 Radiator core
- 40 Right hand plate
- 41 Left hand plate
- 42 Upper tank

Figure 3-3. Radiator assembly, exploded view.

g. Inspect fan guard for damage or unsafe conditions. Inspect mounting hardware for damage. Replace hoses if there is evidence of deterioration.

3-17. Reassembly

Reassemble the radiator assembly as shown in figure

3-3.

3-18. Installation

Install radiator assembly in accordance with TM 5-3810-295-12.

Section IV. REPAIR OF WATER PUMP

3-19. Description

The water pump is of the centrifugal type, and is mounted on top of the engine oil cooler housing. The water pump circulates coolant through the oil cooler, cylinder block, cylinder head and radiator.

3-20. Removal

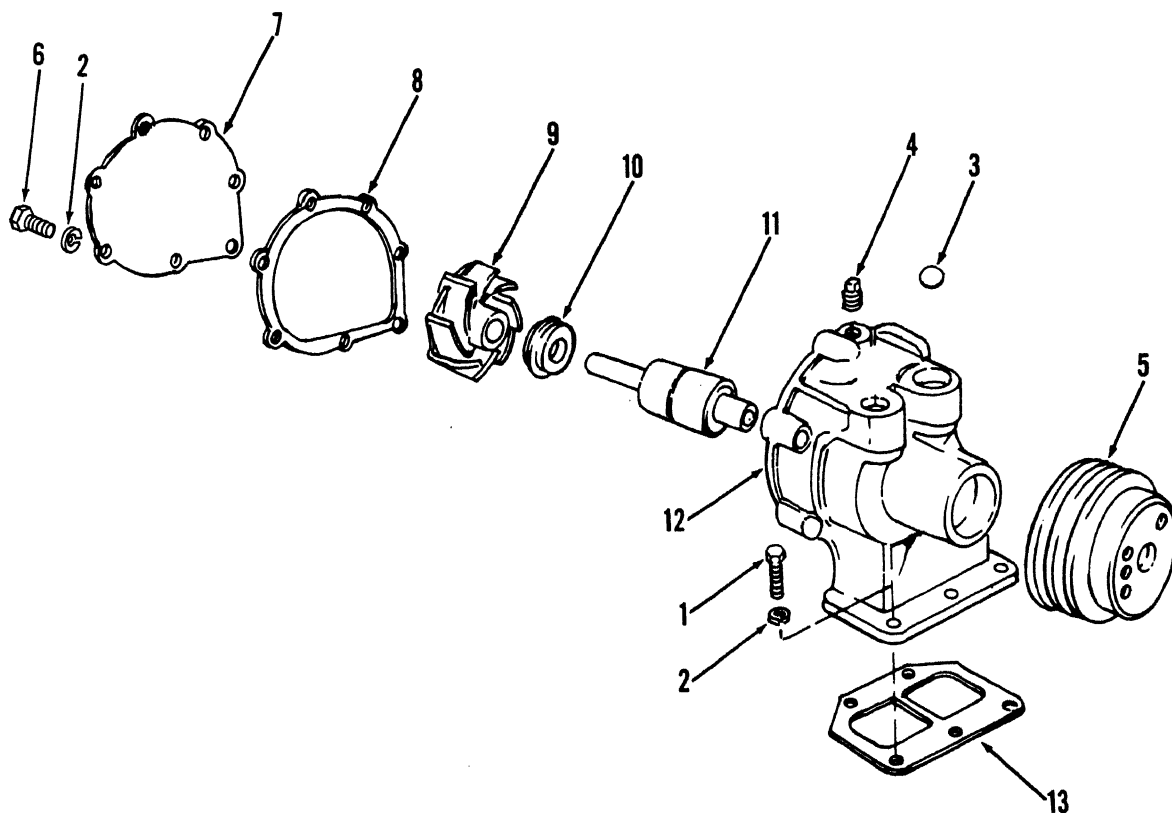
a. Remove radiator cap, and drain the cooling

system.

b. Loosen and remove the water pump belts.

c. Loosen the hose clamps and slide the hose up on the water by-pass tube.

d. Refer to figure 3-4 and remove the five screws (1) and lock washers (2) securing the water pump to the oil cooler housing and take off the pump.



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- 1 Cap screw (5)
- 2 Lock washer (5)
- 3 Rubber ball
- 4 Pipe plug
- 5 Pulley
- 6 Screw/lockwasher (7)
- 7 Pump cover

- 8 Gasket
- 9 Pump impeller
- 10 Pump seal
- 11 Pump shaft
- 12 Pump body
- 13 Pump gasket

Figure 3-4. Water pump assembly, exploded view.

3-21. Disassembly

- a. Note the position of the pulley on the shaft so that the pulley can be reinstalled in the same relative position when the pump is reassembled.
- b. Using a suitable puller, remove the pulley (5) from the shaft. Remove ball (3) and pipe plug (4).
- c. Remove screws and washers (6) and remove pump cover (7). Discard gasket (8).
- d. Press the shaft and bearing assembly, seal the impeller from the pump body as an assembly by applying pressure on the bearing outer race.

CAUTION

The bearing will be damaged if the pump is dismantled by pressing on the end of the pump shaft.

- e. Press the end of the shaft out of the impeller (9) in the direction shown.
- f. Remove seal (10) from the pump shaft and discard it.

3-22. Inspection and Repair

- a. Clean all parts in cleaning solvent, Federal Specification P-D-680, or equivalent.

NOTE

Pump shaft (11) consists of a permanently sealed and lubricated bearing and shaft assembly and should not be washed. Wipe the bearing and shaft with a clean, lintless cloth.

- b. Discard gaskets and seals. Inspect all parts for signs of wear and replace any parts not in good condition.
- c. Examine the impeller for damage and excessive wear on the impeller face which contacts the seal. Replace the impeller if it is worn or damaged.
- d. Discard the bearing if it has a general feeling of roughness, is tight, or shows indications of damage.

3-23. Reassembly

- a. Refer to figure 3-4. Press shaft and bearing (11)

into housing (12) until the outer race of the bearing is flush with the outer face of the pump housing. Apply pressure only to the outer race of the bearing.

NOTE

The bearing will be damaged if pressure is applied to the end of the shaft.

- b. Lightly coat the outside diameter of the new seal (10) with sealing compound such as Loctite. Then with the face of the housing and the bearing outer race supported, install the seal by applying pressure on the seal outer flange, until the flange makes contact with the housing. Wipe the face of the seal with a chamois to remove all dirt and metal particles.
- c. Support the pulley end of the shaft on the bed of an arbor press and press the impeller (9) on the shaft until the impeller is flush with the large end of the housing.
- d. Place the pulley (5) on the bed of an arbor press. Place a suitable rod between the ram of the press and the impeller end of the shaft. Press the shaft into the pulley until the pulley is in its original position on the shaft.
- e. Install a new gasket (8) and cover (7) on the housing. Secure with screw and lock washer (6), tightening the screws to 6—7 ft-lb. (8-9 N·m).
- f. Run the pump dry at 1200 rpm for a minimum of 30 seconds to assure satisfactory seating of the seal. Install plug (4) and ball (3).

3-24. Installation

- a. Install a new gasket (13) on the flange of the water pump body. Secure the water pump on the oil cooler housing with screws (1) and lock washers (2).
- b. Install the hose between the water pump and water by-pass tube and tighten the hose clamps. Install and tighten the belts.
- c. Close all drain cocks and refill the cooling system. Start the engine and check for leaks.

Section V. REPAIR OF OIL COOLER

3-25. Description

The oil cooler is mounted on the lower front engine block. Its purpose is to cool the engine lubricating oil, via coolant from the engine radiator.

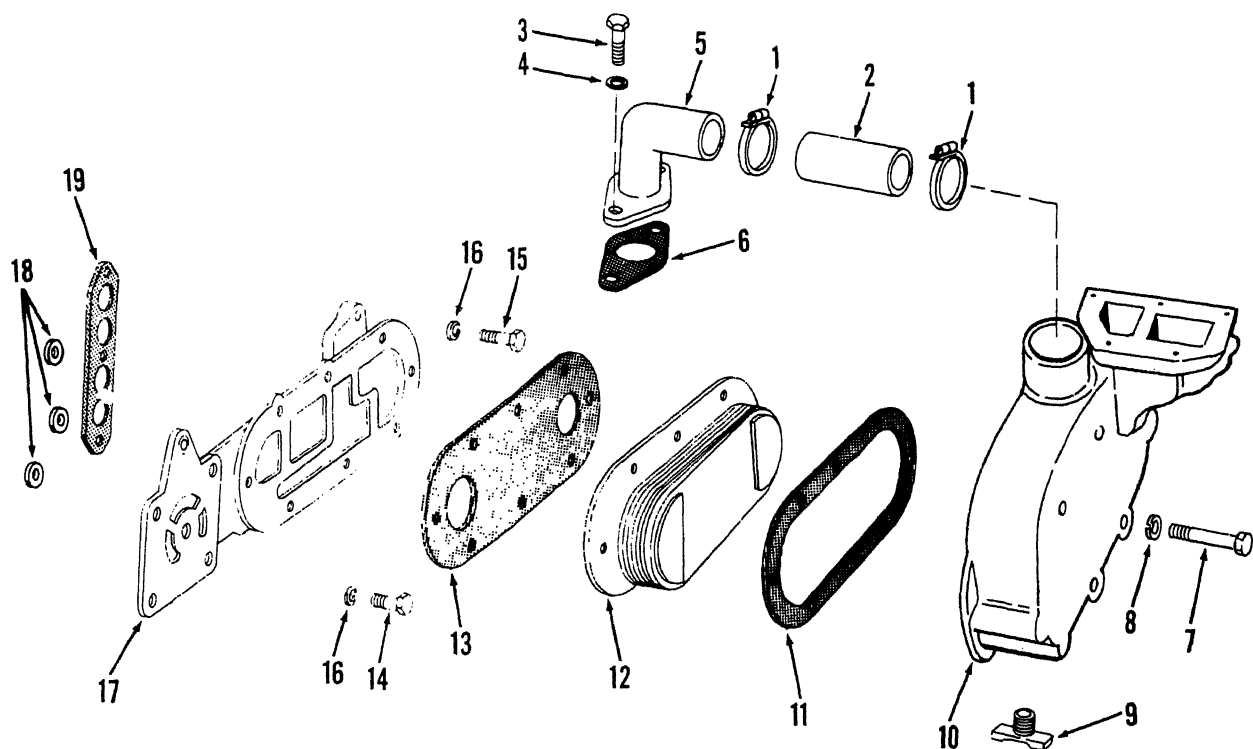
3-26. Removal

- a. Drain the cooling system by opening the drain cock located on the bottom of the oil cooler housing.
- b. Refer to figure 3-5. Remove hose clamps (1) and hose (2). Remove screws (3), lock washers (4), elbow (5) and gasket (6).
- c. Remove screws (7) and lock washers (8). Lift the unit from the engine block.

- d. If adapter (17) is to be removed, the oil filter must first be removed.

3-27. Disassembly

- a. Refer to figure 3-5. Remove drain cock (9) and cooler housing (10).
- b. Matchmark the end of the oil cooler housing, the cooler core (12) and adapter (17) with a punch or file so they can be reassembled in the same position.
- c. Remove gasket (11), core (12) and gasket (13).
- d. Remove screws (14) and (15), and lock washers (16). Separate adapter (17) from the engine block and remove gaskets (18) and (19).



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- 1 Hose clamp (2)
- 2 Hose
- 3 Cap screw (2)
- 4 Lock washer (2)
- 5 Elbow
- 6 Gasket
- 7 Cap screw (8)
- 8 Lock washer (8)
- 9 Drain cock
- 10 Cooler housing

- 11 Gasket
- 12 Core
- 13 Gasket
- 14 Cap screw (4)
- 15 Cap screw (2)
- 16 Lock washer (6)
- 17 Adapter
- 18 Gasket (3)
- 19 Gasket

Figure 3-5. Oil cooler assembly—exploded view.

3-28. Inspection and Repair

a. Remove all traces of gasket material from the cylinder block and the oil cooler components. Replace all gaskets.

b. Circulate cleaning solvent, Federal Specification P-D-680, or equivalent, through the core passages with a force pump to remove the carbon and sludge. Clean the core immediately, before the sludge hardens. If the oil passages are badly clogged, circulate an Oakite or alkaline solution through the core and flush thoroughly with clean, hot water.

c. Clean water side of the cooler by immersing the core in the following solution: Add one-half pound of oxalic acid to a two and one-half gallon solution composed of one-third muriatic acid and two-thirds water. Cleaning action is evidenced by bubbling and foaming. When the bubbling stops (after 30 to 60 seconds) remove the core from the cleaning solution and flush it

thoroughly with clean, hot water. After cleaning, dip the core in light oil.

NOTE

Do not attempt to clean an oil cooler core when an engine failure occurs in which metal particles from worn or broken parts are released into the lubricating oil. In this case, replace the oil cooler core.

d. Using a suitable plate, attach the flanged side of the cooler core to the plate, using a gasket made from rubber to assure a tight seal. Drill and tap the plate to allow an air hose fitting to be attached at the inlet side of the core. Apply approximately 75—150 psi air pressure while the core is submerged in a water bath heated to 180°F. Leaks will be indicated by air bubbles in the water. If leaks are evident, replace the core.

e. After the pressure check is completed, dry the core with compressed air.

f. Check all parts for indications of excessive wear, cracks, or elongation of threads. Replace any parts not in good condition.

3-29. Reassembly

a. Refer to figure 3-5. The oil cooler assembly should be reassembled directly on the engine.

b. Install gaskets (18) and (19), adapter (17) and secure with screws (14) and (15) and lock washers (16).

c. Install new gaskets (11) and (13) on core (12) and insert the core into the cooler housing (10).

NOTE

The inlet and outlet openings in the cooler core are marked accordingly. It is important that the core be installed in the correct position to prevent any sludge or foreign particles remaining in the core from circulating through the engine.

d. Align matchmarks placed on the housing and core, and install the oil cooler core in the oil cooler housing (10).

e. With the matchmarks aligned, place the oil cooler housing and core against the oil cooler adapter. Secure the housing with screws (7) and lock washers (8). Tighten screws (7) to 13—17 ft-lb (18—23 N • m).

f. Install drain cock (9).

3-30. Installation

a. Install new gasket (6) and elbow (5). Secure with screws (3) and lock washers (4). Install hose (2) and secure with hose clamps (1).

b. If adapter (17) was removed, reinstall the oil filter. Be sure the draincock (9) is closed, and fill the cooling system to the proper level.

Section VI. REPAIR OF AIR INLET HOUSING

3-31. Description

The air inlet housing is mounted on the side of the air blower. The housing serves as a mounting for the air filter, and contains an air shut-off valve that shuts off the air supply and stops the engine when emergency shut down is necessary.

3-32. Removal

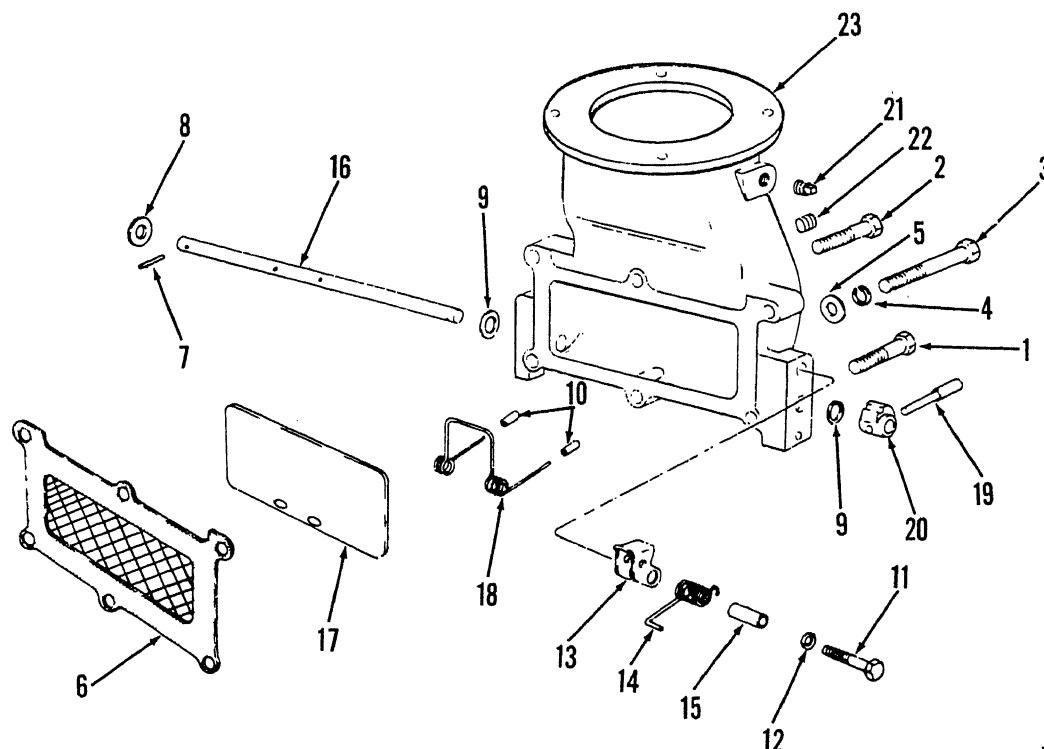
a. Refer to TM 5-3810-295-12 and remove the air

filter assembly.

b. Disconnect the control wire from the air shut off cam pin handle.

c. Refer to figure 3-6 and remove screws (1), (2) and (3), and locknuts (4) and flat washers (5). Lift air inlet housing from the side of the air blower.

d. Cover the air blower opening to prevent dirt or foreign material from entering the blower.



- 1 Cap screw (4)
- 2 Cap screw
- 3 Cap screw
- 4 Lock washer (6)
- 5 Flat washer (6)
- 6 Screen
- 7 Spring pin
- 8 Flat washer
- 9 Shaft seal (2)
- 10 Spring pin
- 11 Cap screw
- 12 Lock washer

- 13 Valve latch
- 14 Spring
- 15 Bearing
- 16 Shaft
- 17 Shutdown valve
- 18 Spring
- 19 Cam handle
- 20 Valve cam
- 21 Pipe plug
- 22 Pipe plug
- 23 Housing

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Figure 3-6. Air inlet housing assembly—exploded view.

3-33. Disassembly

a. Refer to figure 3-6. Remove screen (6). Remove pin (7) from the end of shaft (16), and remove washer (8) and seal (9) from the end of the shaft.

b. Remove pin (10) that secures the shut-off valve (17) to the shaft.

c. Remove screw (11) and lock washer (12) that secures the latch to the housing. Then remove valve latch (13), spring (14) and bearing (15).

d. Note the position of the air shut-off valve spring (18), then withdraw shaft (16) from the housing to release valve (17) and spring (18).

e. Remove cam handle (19) and withdraw cam (20) from the shaft. Remove seal (9) from the housing. Remove pipe plugs (21) and (22) from the housing.

3-34. Inspection and Repair

a. Clean all parts in cleaning solvent, Federal Specification P-D-680, or equivalent, before inspection.

b. Check all parts for excessive wear and replace any parts not in good condition.

c. Check the face of shut-down valve (17) for warp-age. The face of the valve must be flat to assure a tight seal when it is in the shut down position.

3-35. Reassembly

a. Refer to figure 3-6. In a new valve or shaft is to be installed, $\frac{1}{8}$ -inch holes must be drilled in the shaft for the cam handle and valve. The valve must be within 0.03 inch of the plane of the housing opening when the valve is in the stop position.

b. Place valve (17) and spring (18) in position in the housing and slide shaft (16) in place. The shaft must extend 0.70 inch from the side of the housing where the shut-down valve is assembled.

c. Install a new seal ring (9) at each end of the shaft. Be sure the seals are seated in the counterbores of the housing.

d. Install cam (20) and cam handle (19) on the shaft. Install washer (8) and pin (7) on the other end of the shaft.

e. Assemble bearing (15), spring (14) and valve latch (13) in the housing and lightly secure with screw (11) and lock washer (12).

f. Align the notch on the bearing with the notch on the latch and lock the bearing in this position.

g. Install pin (10) in valve (17) to retain it to the shaft with the cam release latch set and the valve in the run position.

h. Level the valve in the shut down position, and adjust the bearing to the valve contacts the housing when

the cam release latch is set.

3-36. Installation

a. Place screen and gasket assembly (6) in position with the screen side of the assembly toward the blower.

b. Install and finger tighten screws (1), (2) and (3) with lock washers (4) and flat washers (5).

c. Tighten the two center screws to 16—20 ft-lb (22—27 N · m).

d. Then tighten the four corner bolts to 16—20 ft-lb (22—27 N · m).

CAUTION

A power wrench should not be used to tighten these screws.

Section VII. REPAIR OF AIR BLOWER

3-37. Description

The air blower supplies fresh air required for combustion and scavenging. Its operation is similar to that of a gear-type oil pump. Two hollow double-lobe rotors revolve in a housing bolted to the side of the engine. The revolving motion of the rotors provides a continuous and uniform displacement of air.

3-38. Removal

a. Refer to TM 5-3810-295-12 and remove the air filter and air inlet housing.

b. Refer to figure 3-7 and loosen clamp (1).

c. Remove screws (2) and washers (3). Lift air blower assembly from the engine.

d. Remove gasket (4) from the engine.

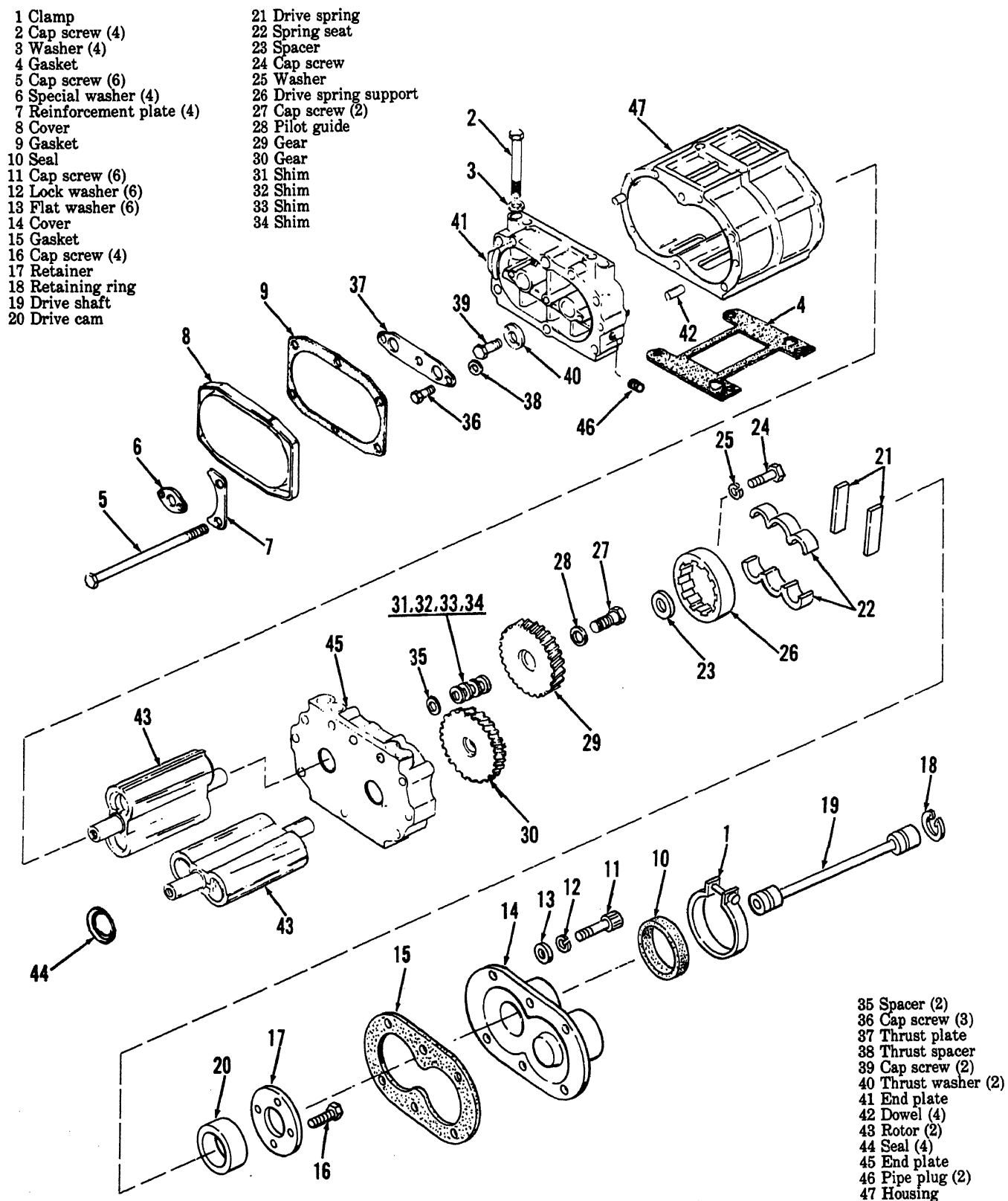
3-39. Disassembly

a. Remove screws (5), special washers (6) and reinforcement plates (7), and remove front cover (8) and gasket (9) from the end plate.

b. Remove seal (10), screws (11), lock washer (12) and flat washers (13), and remove rear cover (14) and gasket (15).

c. Wedge a clean cloth between the rotors to prevent their turning and remove screws (16) and retainer (17). Remove retaining ring (18) and slide drive shaft (19) from the assembly.

d. Remove drive cam (20), springs (21), spring seats (22) and spacer (23). Remove screw (24), washer (25) and drive spring support (26).



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Figure 3-7. Air blower assembly—exploded view.

e. Remove screws (27) and cam pilot (28). Mark the upper gear for reassembly purposes.

f. Use two pullers, and remove gears (29) and (30) simultaneously. Remove shims (31), (32), (33) and (34), and remove spacers (35). Place the shims and spacers with their respective gears to assure proper reassembly.

g. Remove screws (36), thrust plate (37) and thrust spacer (38). Remove screws (39) and thrust washer (40).

h. Gently tap the end plate (41) off the dowel pins (42) with a soft (plastic) hammer, being careful not to damage the mating surfaces of the end plate and housing.

i. Remove rotors (43) and seals (44). Remove end plate (45) in the same manner as end plate (41).

j. Remove pipe plug (46) from housing (47).

3-40. Inspection and Repair

a. Clean all parts with cleaning solvent, Federal Specification P-D-680, or equivalent, before inspecting.

b. Replace all seals and gaskets.

c. The finished inside face of each end plate must be smooth and flat. Slight scoring may be cleaned up with

a fine grit emery cloth. If the surface is badly scored, replace the end plate.

d. Inspect the surfaces of the rotors and the blower housing. Remove burrs and scratches with an oil stone.

e. Examine the rotor shafts, gear and drive coupling for burred or worn serrations.

f. Inspect the blower gears for excessive wear or damage, especially for cracks at the roots of the teeth.

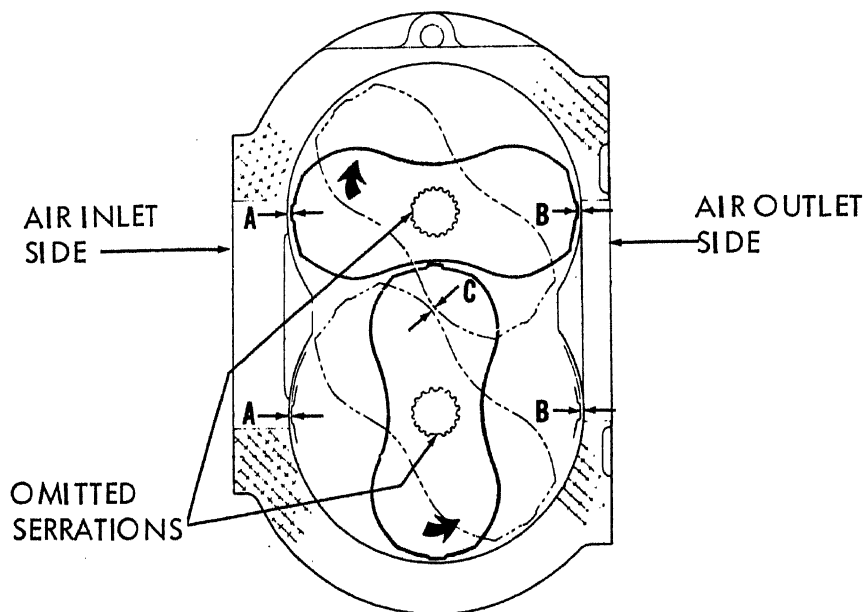
g. Check the bearing and oil seal contact surfaces of the rotor shafts and end plates for scoring, wear or nicks.

3-41. Reassembly

a. Refer to figure 3-7. Place the end plate on the bed of an arbor press. Lubricate the outer diameter of seal (44) and press the seal (lip facing down) into the counterbore hole until the face of the seal is within 0.002 to 0.008 inch below the finished face of the end plate.

b. Place the front end plate (41) on two wooden blocks, finished side up. Install rotors (43), gear end up, on the end plate at 90° angles, as shown in figure 3-8.

c. Install dowels (42) and place blower housing (47) over the rotors.



MINIMUM BLOWER ROTOR CLEARANCES

A = 0.0075 INCH

B = 0.004 INCH

C = 0.010 INCH

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Figure 3-8. Blower rotor clearances.

d. Place the rear end plate (45) over the rotor shafts and on the housing, and temporarily secure each end plate to the blower housing with four screws and flat washers.

e. Install screws (39) and thrust washers (40) in the front end of the blower. Install spacers (38) and thrust plate (37) and secure with screws (36). Tighten screws (36) to 7–9 ft-lb (9–12 N·m). Then check the clearance between thrust plate (37) and thrust washers (40). The specified clearance is 0.001 to 0.003 inch.

f. Position rotors (43) so that the missing serrations on the gear end of the shafts are 90° apart, as shown in figure 3-8. This is accomplished by placing the rotors in the shape of a "T" with the missing serration in the upper rotor facing to the left and the missing serration in the lower rotor facing toward the bottom. Install spacers (35) and shims (31), (32), (33) and (34) in the counterbore in the rear face of the rotor gears. Then place gears (29) and (30) on the ends of the shafts with the missing serrations in alignment with the missing serrations on shafts.

g. Tap the gears lightly with a soft hammer to seat the gears on the shafts. Then rotate the gears until the punch marks on the face of the gears match. If the punch marks do not match, reposition the gears.

h. Wedge a clean cloth between the blower rotors. Use the gear retaining bolts and flat washers to press the gears on the rotor shafts. Turn the bolts uniformly until the gears are tight against the shoulders of the shafts.

i. Remove the gear retaining bolts and washers and place the blower drive cam pilot (28) in the counterbore of the upper gear and start the gear retaining screws (27) in the rotor shaft. Tighten the bolts to 25–30 ft-lb (34–41 N·m).

j. Check backlash between the blower gears, using a suitable dial indicator. The correct backlash is 0.0005 to 0.0025 inch, for new gears, or a maximum of 0.0035 with used gears.

k. After the rotors and gears have been installed, the blower rotors must be timed. When properly positioned, the blower rotors run with a slight clearance between the rotor lobes and between the lobes and the walls of the housing. Clearances between the rotors may be varied by moving one of the gears in or out on the shaft relative to the other gear by adding or removing shims between the gear hub and the rotor spacers. It is preferable to measure the clearances with a feeler gage comprised of two or more feelers, because a combination of feelers is more flexible. Take the measurements from both the inlet and outlet sides of the blower.

(1) Measure the clearance between the rotor lobes and the housing as shown in figure 3-8. Take measurements across the entire length of each rotor lobe to be certain that a minimum clearance of 0.004 inch exists

at the air outlet side, and a minimum of 0.0075 inch at the air inlet side.

(2) Measure the clearance between rotor lobes, across the entire length of the lobes. By rotating the gears, position the lobes so that they are at their closest relative position. Clearance between lobes should be a minimum of 0.010 inch.

(3) Measure the clearance between the end of the rotor and the blower end plate through the inlet and outlet openings. Clearances should be a minimum of 0.006 inch for the front end plate, and .009 inch for the rear end plate.

NOTE

Push and hold the rotor toward the end plate at which the clearance is being measured.

L. Remove the screws and washers used to temporarily secure the front end plate to the housing. Then install gasket (9), cover (8), special washers (6) reinforcement plates (7) and screws (5). Tighten the screws to 20–25 ft-lb (27–34 N·m).

m. Assemble the blower drive spring support as follows:

(1) Place drive spring support (26) on two blocks of wood.

(2) Position drive spring seats (22) in the support.

(3) Apply grease to springs (21) to hold the leaves together, and then slide the two spring packs in place.

(4) Press drive cam (20) between the spring packs.

n. Install the drive spring support assembly on the rotor gear at the rear end of the blower.

o. Install retainer (17) and secure with screws (16). Tighten the screws to 8–10 ft-lb (11–14 N·m).

p. Remove the bolts and washers used to temporarily secure the rear end plate to the housing, and install gasket (15), plate cover (14) and secure with screws (11), special washers (6), reinforcement plates (7), lock washers (12) and flat washers (13). Tighten screws to 20–25 ft-lb (27–34 N·m).

3-42. Installation

a. Examine the inside of the blower for any foreign objects. Also revolve the rotors by hand to assure that they turn freely.

b. Install gasket (4) on the side of the engine block. (Use adhesive only on the block side of the gasket.)

c. Install seal (10) and clamp (1) on the blower rear end plate cover.

d. Slide one end of the blower drive shaft (19) into the drive cam, and position the blower on the side of the engine block. Use care so as not to damage or dislocate the gasket.

e. Secure the blower assembly to the engine block with screws (2) and washers (3). Tighten the screws to 55–60 ft-lb (75–81 N·m). Install retainer ring (18).

f. Slide the seal (10) and clamp (1) back against the

blower drive gear support and tighten the clamp to hold the seal in place.

g. Check backlash between the blower drive gear and the camshaft gear. Backlash should be 0.003 to

0.007 inch.

h. Refer to TM 5-3810-295-12 and install air inlet housing and air filter.

Section VIII. REPAIR OF FUEL TANK

3-43. Description

The fuel tank is located in the crane engine compartment, and provides the function of fuel storage and supply for the crane engine.

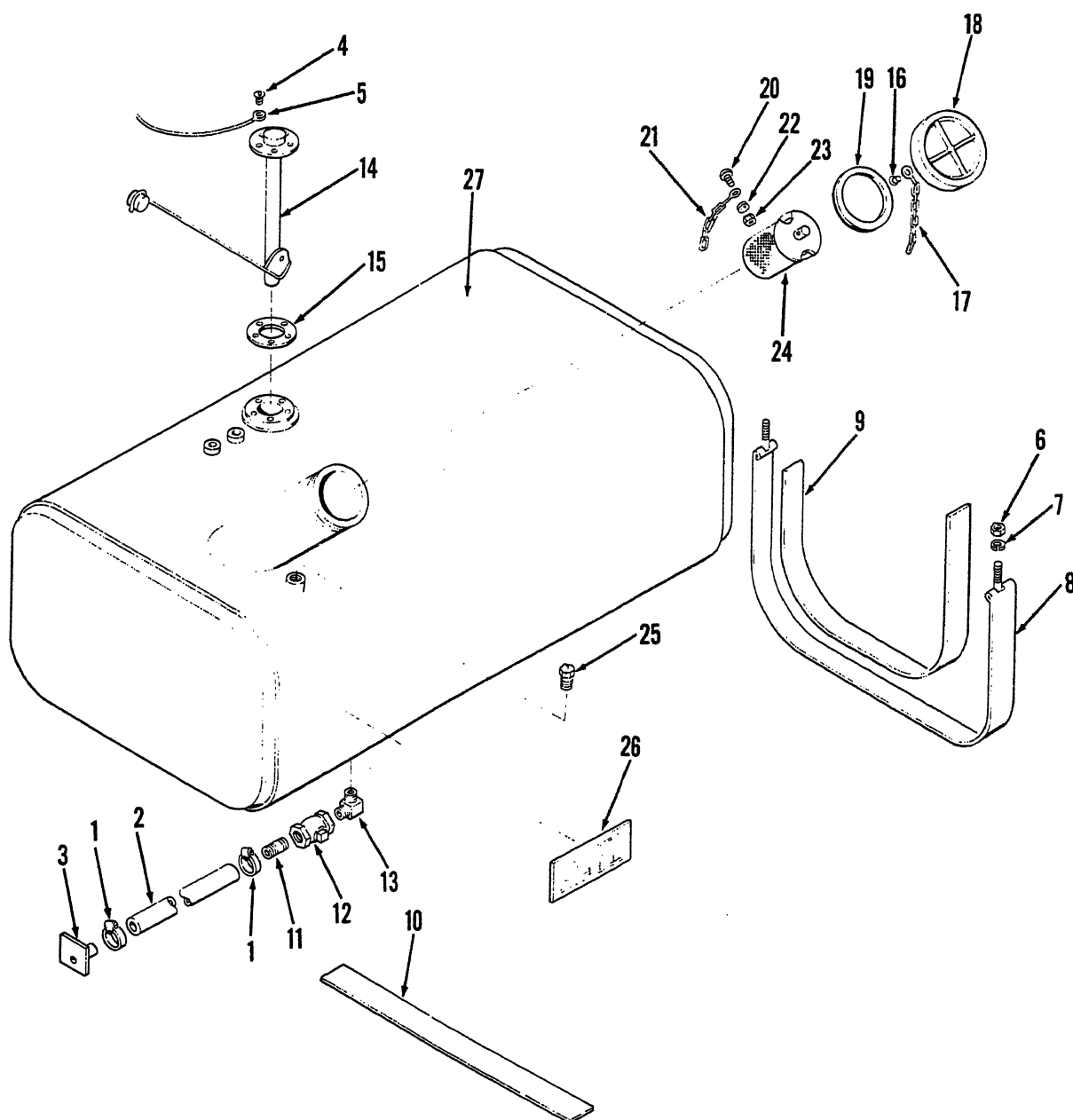
3-44. Removal

a. Refer to figure 3-9 and open drain cock (12).

Drain fuel into a suitable container.

b. Remove hose clamps (1), hose (2), and plate (3). Remove screws (4) and electrical lead (5).

c. Remove nuts (6) and washers (7), and lift the tank assembly from the engine compartment.



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- 1 Hose clamps (2)
- 2 Hose
- 3 Plate
- 4 Screw (5)
- 5 Electrical lead
- 6 Nut (4)
- 7 Flat washer (4)
- 8 Mounting strap (2)
- 9 Strap (2)

- 10 Strip (3)
- 11 Pipe nipple
- 12 Drain cock
- 13 Elbow
- 14 Transmitter
- 15 Gasket
- 16 Screw
- 17 Chain
- 18 Cap

- 19 Gasket
- 20 Screw
- 21 Chain
- 22 Lock washer
- 23 Nut
- 24 Screen
- 25 Vent
- 26 Safety label
- 27 Fuel tank

Figure 3-9. Fuel tank assembly—exploded view.

3-45. Disassembly

a. Remove mounting strips (8), straps (9) and strips (10). Remove pipe nipple (11), drain cock (12) and elbow (13).

b. Lift transmitter (14) and gasket (15) from the tank.

c. Remove screws (16), chain (17), cap (18) and gasket (19).

- d. Remove screw (20), chain (21), lock washer (22), nut (23) and screen (24) from the assembly.
- e. Remove vent (25) from tank (27).

3-46. Inspection and Repair

- a. Clean all parts with cleaning solvent, Federal Specification P-D-680, or equivalent.
- b. Inspect all parts for indications of excessive wear.
- c. Inspect hose for deterioration or cracks. Replace hose if not in good condition.
- d. Replace all gaskets.
- e. Inspect tank for leaks, cracks or breaks. If welding is necessary, steam clean the interior of the tank with live steam for at least 8 hours, to remove any fuel, before welding.

WARNING

Refer to TM 9-237 for safety precautions for welding containers that have held combustibles.

3-47. Reassembly

- a. Refer to figure 3-9. Install vent (25) and safety label (26) if it was removed.

- b. Assemble screen (24), nut (23), lock washer (22), chain (21), and screw (20) and install the assembly into the fuel tank inlet.

- c. Install new gasket (19), screw (16), chain (17) and cap (18).

- d. Install new gasket (15) and transmitter (14). Lightly secure the transmitter to the tank with four screws (4).

- e. Install elbow (13), drain cock (12) and pipe nipple (11).

- f. Install strips (10), straps (9) and mounting strips (8). Install fuel tank assembly into position in the engine compartment.

3-48. Installation

- a. Secure tank into position with washers (7) and nuts (6).

- b. Install electrical lead (5) and secure the lead with screw (4). Tighten remaining screws (4).

- c. Install plate (3), hose (2) and secure the hose with hose clamps (1).

Section IX. REPAIR OF FUEL PUMP

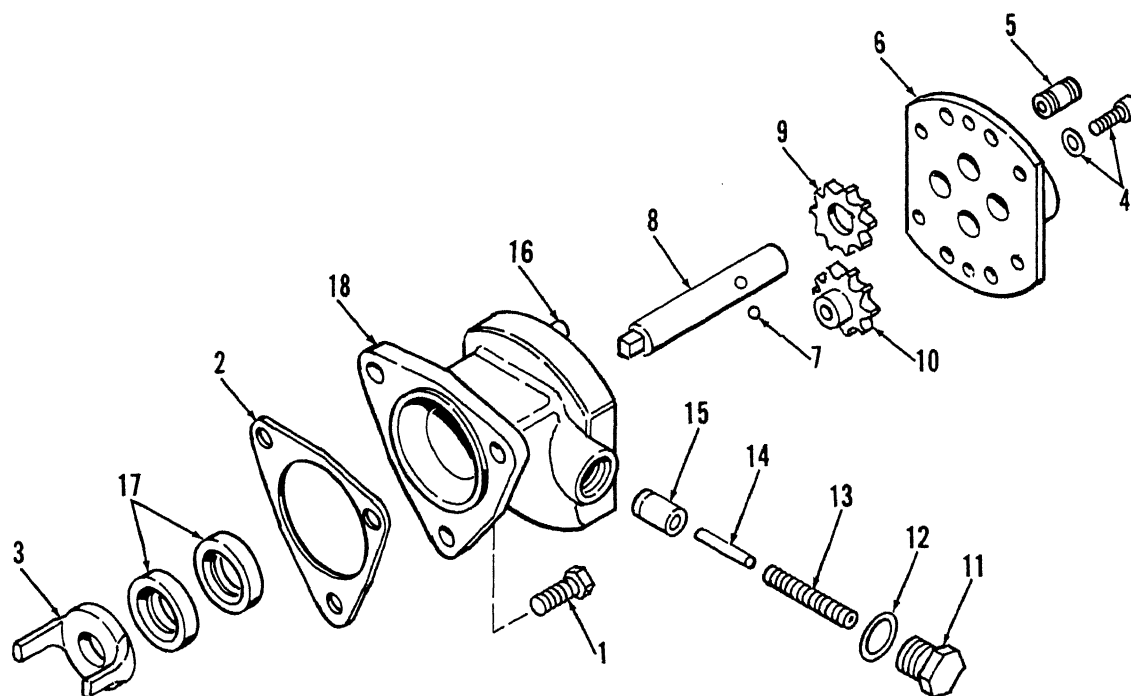
3-49. Description

The fuel pump is a positive displacement, gear type pump which transfers fuel from the supply tank to the fuel injectors. The pump circulates an excess supply of fuel through the injectors which purges the air from the system and cools the injectors.

3-50. Removal

- a. Refer to TM 5-3810-295-12 and disconnect the fuel lines from the inlet and outlet openings in the fuel pump.

- b. Refer to figure 3-10 and remove the three pump attaching screws (1) and withdraw the pump. Remove gasket (2).



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- 1 Cap screw (3)
- 2 Gasket
- 3 Coupling fork
- 4 Cap screw and washer
- 5 Bushing
- 6 Cover
- 7 Locking ball
- 8 Drive shaft
- 9 Drive gear

- 10 Gear and shaft
- 11 Valve plug
- 12 Gasket
- 13 Spring
- 14 Valve pin
- 15 Relief valve
- 16 Pin (2)
- 17 Shaft seal (2)
- 18 Fuel pump body

Figure 3-10. Fuel pump assembly—exploded view.

3-51. Disassembly

a. Refer to figure 3-10. Remove coupling fork (3). Remove cover screws (4) and bushing (5). Separate cover (6) from the pump body, using care not to damage the finished faces of the pump body and cover.

b. Withdraw drive shaft (8), drive gear (9) and gear retaining ball (7) from the unit as an assembly.

c. Press the drive shaft (8) just far enough to remove the steel locking ball (7). Then invert the shaft and gear assembly and press the shaft from the gear.

CAUTION

Do not press the squared end of the shaft through the gear. The squared end will cause slight scoring of the oil seal contact surface.

d. Remove shaft and gear (10) as an assembly from the pump body. Do not attempt to remove the gear from the shaft. The driven gear and shaft are treated as an assembly.

e. Remove relief valve plug (11), and remove gasket (12), spring (13), valve pin (14) and relief valve (15) from the pump body.

f. Remove alignment pins (16). Remove oil seals (17) from the pump body (18).

3-52. Inspection and Repair

a. Clean all parts with cleaning solvent, Federal Specification P-D-680, or equivalent, before inspection.

b. Oil seals once removed from the pump body, must be replaced. Replace all gaskets.

c. Check pump gear teeth for scoring, chipping, cracks or wear. Check the ball slot in the drive gear for wear. Replace the gear if the slot is badly worn.

d. Inspect the drive and driven shafts for scoring or wear.

e. The mating surfaces of the pump body and pump body cover must be flat and smooth, and must fit tightly together. Any scratches or slight damage may result in pressure leaks. Also check for wear at areas contacted by gears and shafts. Replace the cover and/or body if necessary.

f. The relief valve must be free from score marks and burrs, and must fit its seat in the pump body. If the

relief valve is scored and cannot be cleaned up with fine emery cloth or crocus cloth, replace the valve.

3-53. Reassembly

a. Refer to figure 3-10. Lubricate the lips of oil seals (17) and install the seals in pump body (18). Install the seals so that the seal lips point away from the gears, and so that the space between the seals corresponds to the drain holes in the bottom of the pump body.

b. Clamp the pump body in a bench vise (equipped with soft jaws) with the cavity end up. Lubricate the outside diameter of the relief valve (15) and place it in the cavity with the hollow end up. Insert spring (13) into the valve, and insert pin (14) into the spring. Install a new gasket (12) and install valve plug (11) into the pump body.

c. Install drive gear (9) on shaft (10) over the end of the shaft that is not squared. The slot in the gear must face the plain end of the shaft. Press the gear beyond the retaining ball detent. Place ball (7) into the detent and press the gear back until the end of the slot contacts the ball.

d. Lubricate the pump shaft and insert the square end of the shaft into the opening at the gear side of the pump body and through the oil seals previously installed.

e. Install gear and shaft (10) in the pump body.

NOTE

The gear (10) must be centered on the shaft to give proper end clearance. Also, the cham-

fered end of the gear teeth must face the pump body.

f. Lubricate the gears and shafts with clean engine oil.

g. Apply a thin coating of Loctite sealant, or equivalent, on the face of the pump cover outside the gear pocket area. Install alignment pins (16) and place the pump cover (6) against the pump body. (With the two alignment pins installed, the cover can only fit the pump body in one position.)

NOTE

The coating of sealant must be extremely thin, because pump clearances are set on the basis of metal-to-metal contact. Use care that the sealant is not squeezed into the gear compartment or damage may result to the gears and shafts.

h. Install bushing (5) and secure the cover into position with screws (4). Tighten the screws alternately and evenly.

i. Rotate the pump shaft manually to assure that the parts rotate freely. If the shaft does not rotate freely, gently tap a corner of the pump.

3-54. Installation

a. Install coupling (3) on the drive shaft end. Install a new gasket (2) on the engine. Install the pump assembly on the engine and secure with screws (1).

b. Refer to TM 5-3810-295-12 and connect the fuel lines to the pump.

Section X. REPAIR OF ENGINE GOVERNOR

3-55. Description

The variable speed mechanical governor holds the engine at any constant speed, between idle and maximum, as desired by the operator. The governor is mounted on the rear end plate of the engine and is driven by a gear that extends through the end plate and meshes with the balance shaft gear.

3-56. Removal

a. Refer to TM 5-3810-295-12 and paragraph 3-50 and remove the fuel pump and associated fuel lines.

b. Refer to figure 3-11. Remove spring (1), bracket (2), screw (3), lock washer (4) and throttle lever (5).

c. Loosen hose clamps (6) and slide hose (7) to one side. Remove cotter pin (8), spring retainer (9), flat washer (10) and link (11).

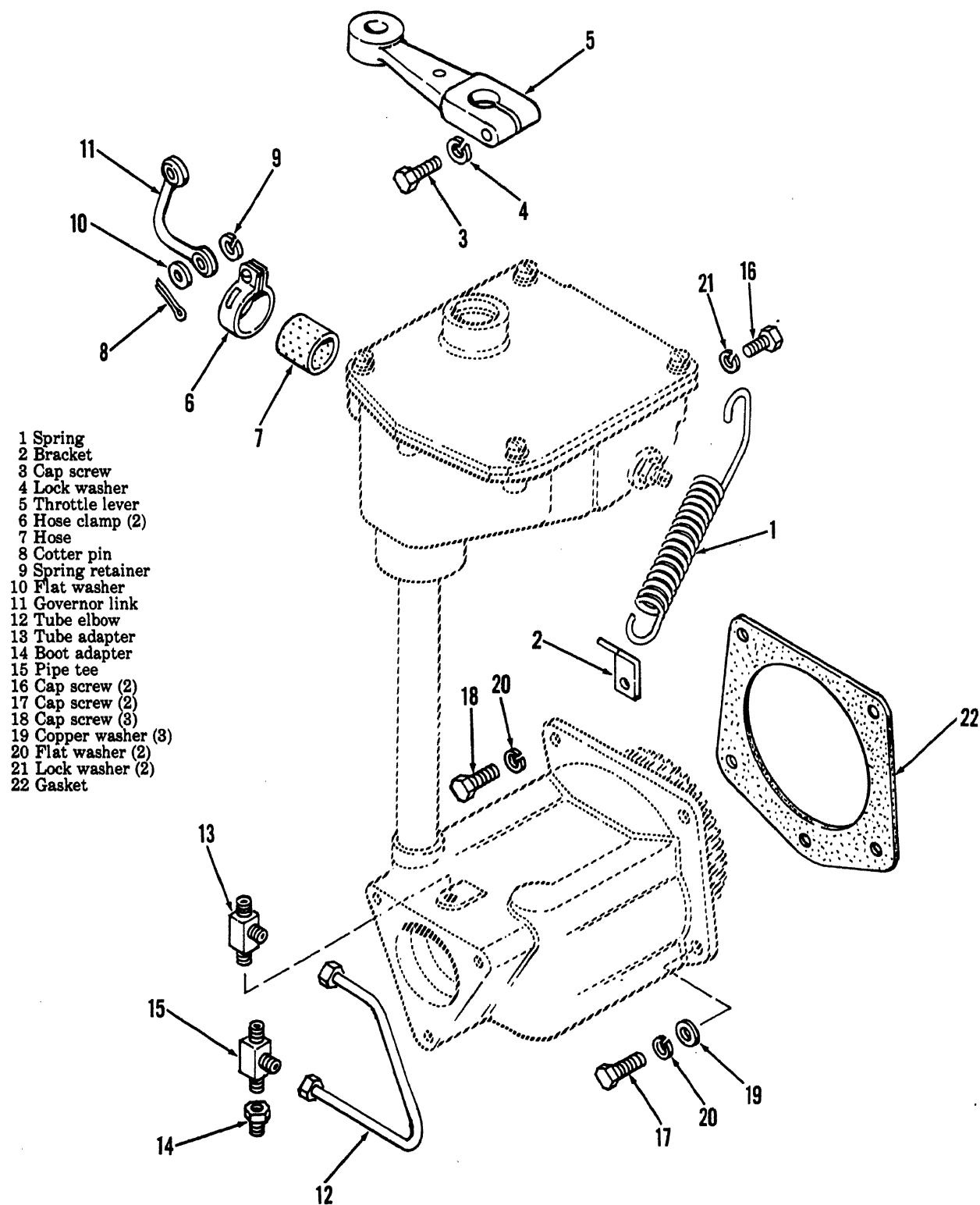
d. Remove lubrication tube elbow (12), tube adapter (13), boot adapter (14) and pipe tee (15).

e. Remove mounting screws (16), (17) and (18) and lock washers (19), (20) and (21). Lift the assembly from the engine and remove gasket (22).

3-57. Disassembly

a. Refer to figure 3-12. Remove screws (1) and (2), washers (3), cover (4) and gasket (5).

b. Remove pin retainer (6), washer (7), differential lever (8) and pin (9).



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Figure 3-11. Governor mounting hardware—exploded view.

c. Remove two screws (10), lock washers (11) and spring housing (12). Then remove spring retainer (13), shims (14), retainer stops (15) and (16), spring (17), spring plunger (18), spring guide (19), guide bushing (20), and gasket (21).

d. From the opposite side of the control housing, remove buffer screw (22) and nut (23).

e. Rotate the shaft until adjusting screw (24) is accessible through the housing opening. Remove screw (24), nut (25), lever assembly (26), and lever pin (27).

f. Remove bearing screw (28) and bearing (29) from the operating shaft.

g. Remove lock nut (30) from the drive shaft, and remove gear (31) and Woodruff key (32). Slide gear spacer (33) from the shaft, then remove two screws (34), lock washers (35) and lever fork (36) from weight housing (45).

h. Shaft tube (37) and operating shaft (38) can now be removed along with control housing (39).

i. Remove shaft assembly (40) from the weight housing, and press bearing (41) from the housing counter-bore.

j. Remove plug (42) and retaining ring (43) from housing (45), and press operating shaft bearing (44) from the housing.

k. A portion of the governor controls are located on the engine head, along with the injectors. Remove cotter pin (46), pin (47), and link (48). Then remove pin (49), link adapter (50), and lever spacer (51) from tube shaft (57).

l. Remove screws (52) and tube brackets (53) from the engine head. Slide the tube brackets off the shaft along with spring (54).

m. Remove lever screws (55) and slide control levers (56) from shaft (57).

n. Remove screws (58), lock washers (59), lever arm (60). Remove adjusting screw (61), lock nut (62) and lever plate (63).

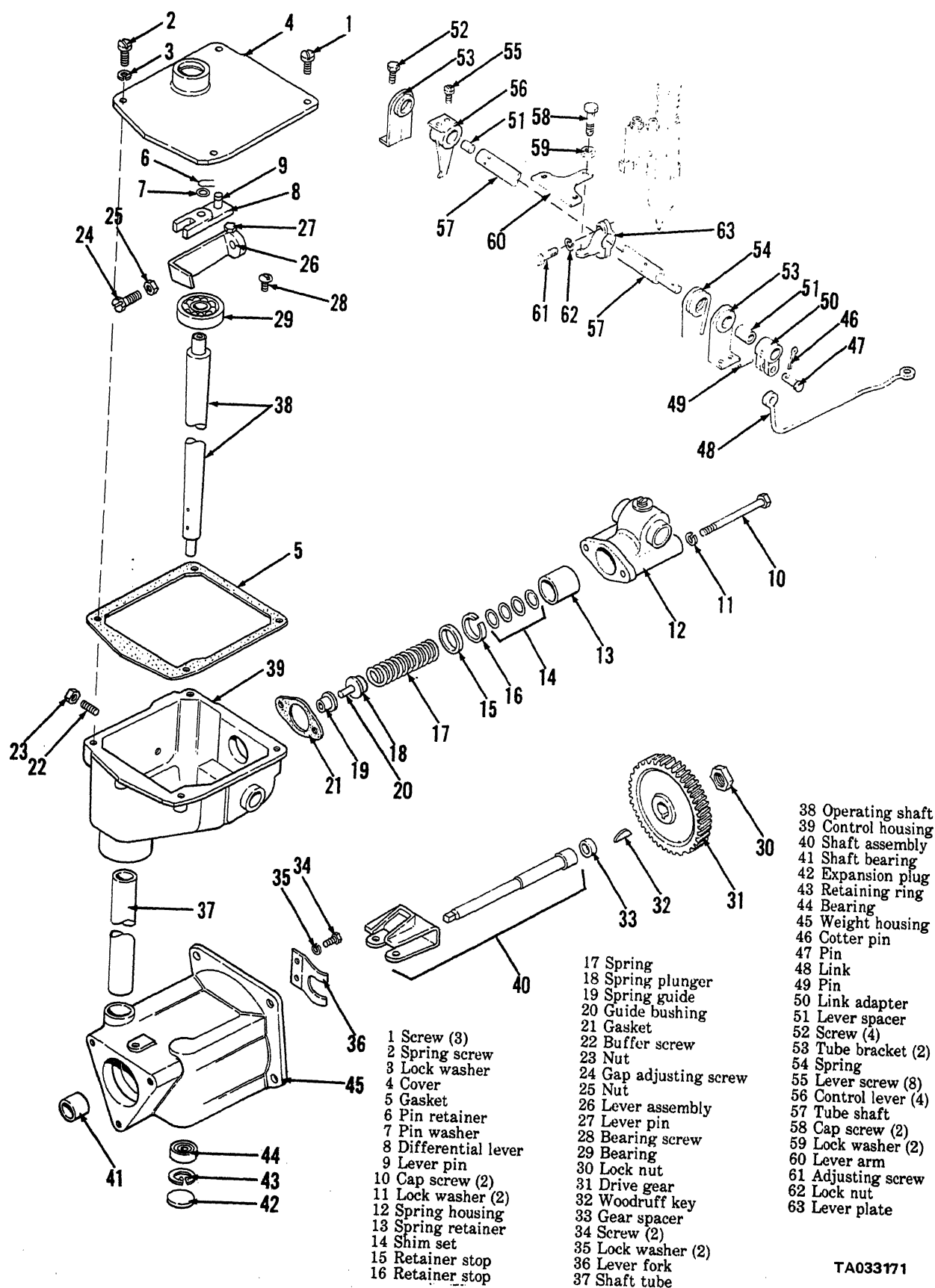


Figure 3-12. Governor assembly—exploded view.

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3-58. Inspection and Repair

a. Clean all parts in cleaning solvent, Federal Specification P-D-680, or equivalent, before inspecting the parts.

b. Replace all gaskets and cotter pins.

c. Inspect all governor components for excessive wear and damage. Replace any worn or damaged parts.

d. Revolve ball bearings slowly by hand. Replace bearings that have rough or tight spots. Replace bearings that are corroded or pitted.

e. Visually inspect the fuel pump end of the drive shaft. Replace shaft if the end is rounded or worn.

f. Examine the variable speed spring lever for signs of excessive wear.

3-59. Reassembly

a. Refer to figure 3-12. Install lever plate (63) and secure with lock nut (62). Assemble and install lever arm (60) and adjusting screw (61) and secure with screws (58) and lock washers (59).

b. Slide control levers (56) onto shaft (57), along with spring (54) and tube brackets (53). Position the assembly on the engine head and secure the tube brackets with screws (52). Secure control levers in position with screws (55).

c. Install lever spacer (51) and link adapter (50) on the end of shaft (57). Secure the link adapter with pin (49). Install fuel rod link (48) and secure it to shaft (57) with pin (47) and cotter pin (46).

d. Lubricate bearings (41) and (44) and press the bearings into the counterbores of housing (45). Install retaining ring (43) and expansion plug (42).

e. Lubricate bearing (29) and press it onto operating shaft (38). Assemble the operating shaft, shaft tube (37) and control housing (39). Lubricate the shaft and install the assembly on weight housing (45). Secure bearing (29) with bearing screw (28).

f. Install lever fork (36) in housing (45), and secure lightly with screws (34) and lock washers (35).

g. Assemble gear spacer (33) and gear (31) on the drive shaft, and secure the gear with Woodruff key (32) and lock nut (30). Install the assembly in housing (45). Tighten screws (34).

h. Assemble spring retainer (13), shims (14), retainer stops (15) and (16), spring (17), spring plunger (18), spring guide (19) and guide bushing (20) into spring housing (12). Install a new gasket (21) on the control housing, and secure the assembly with screws

3-60. Installation

a. Refer to figure 3-11. Install a new gasket (22) and place the governor assembly into position on the engine. Be sure the teeth on the drive gear mesh with the teeth on the balance shaft gear. Install screws (18), and (17) along with washers (19) and (20). Tighten the screws to 35 ft-lb (47 N · m).

b. Slip hose (7) and hose clamps (6) into position on the control housing. Then insert governor link (11) through the hose and secure with spring retainer (9), washer (10) and cotter pin (8).

c. Install control housing screws (16) and lock washers (21). Tighten the screws to 10 to 12 ft-lb (14—16 N · m).

d. Install the lubricating lines, adapter (13), adapter (14), tee fitting (15) and elbow (12) on the weight housing.

e. Refer to figure 3-12 and install new gasket (5) on the control housing. Install cover (4) and secure with screws (1) and lock washers (3). Refer to figure 3-11 and install throttle lever (5), screw (3) and lock washer (4). Install spring (1) and bracket (2), and secure with spring screw (2, fig. 3-12).

f. Refer to TM 5-3810-295-12 and install the fuel pump and associated fuel lines.

g. Position the injector rack control levers as follows:

(1) Refer to figure 3-12 and loosen all injector rack control levers adjusting screws. Be sure levers are free on the tube shaft. Disconnect governor link (11, fig. 3-11).

(2) Move throttle lever (5, fig. 3-11), to the maximum speed position.

(3) Adjust rear cylinder injector rack control lever (56, fig. 3-12) adjusting screws (55) until both screws are equal in height and tighten them on tube shaft (57).

(4) Move the rear injector control lever (56) to the full fuel position and note the clearance between the linkage and cylinder head bolt. Clearance should be one thirty-second and one-sixteenth of an inch. Readjust rear cylinder injector rack control lever (56) adjusting screws (55) is necessary.

(5) Position governor linkage to retain the adjustment. Check the adjustment by pushing the linkage toward the engine and make sure the injector rack is in the full fuel position. Readjust the linkage if necessary.

(6) Hold the rear injector rack in the full fuel position and turn the inner adjusting screw of the adjacent injector rack control lever down until the rack moves into the full fuel position. Turn the outer adjusting screw down until it bottoms lightly on the tube shaft. Alternately tighten both the inner and outer adjusting screws to a torque of 2—3 ft-lb (3—4 N · m).

(7) Recheck the rear injector rack. If it has loosened, back off the inner adjusting screw on the adjacent rack control lever and tighten the outer adjusting screw. When the settings are correct, the racks of

both injectors must be snug on the ball end of their respective control levers.

(8) Position the remaining control levers in accordance with steps 6 and 7.

h. With the engine running at idle speed, turn buffer screw (22, fig. 3-12), so that it contacts the stop

lever lightly, while still eliminating engine roll.

NOTE

Do not raise engine speed more than 20 RPM with the buffer screw.

i. Secure buffer screw (22) in position with locknut (23).

Section XI. REPAIR OF FUEL INJECTOR

3-61. Description

The fuel injector performs four basic functions: 1) Creates high fuel pressure required for efficient operation, 2) meters and injects the exact amount of fuel required to handle the load, 3) atomizes the fuel for mixing with air in the combustion chamber, and 4) permits continuous fuel flow. The injector is controlled by action of the engine governor.

3-62. Removal

a. Refer to figure 3-13. Remove the valve rocker cover.

b. Remove the fuel pipes from both the injector and fuel manifold.

CAUTION

Upon removal of the fuel lines, cover the injector filter caps to prevent dirt or foreign

material from entering the injector. Also cover the fuel manifold openings.

c. Crank the engine to bring the outer ends of the push rods of the injector and valve rocker arms in line horizontally.

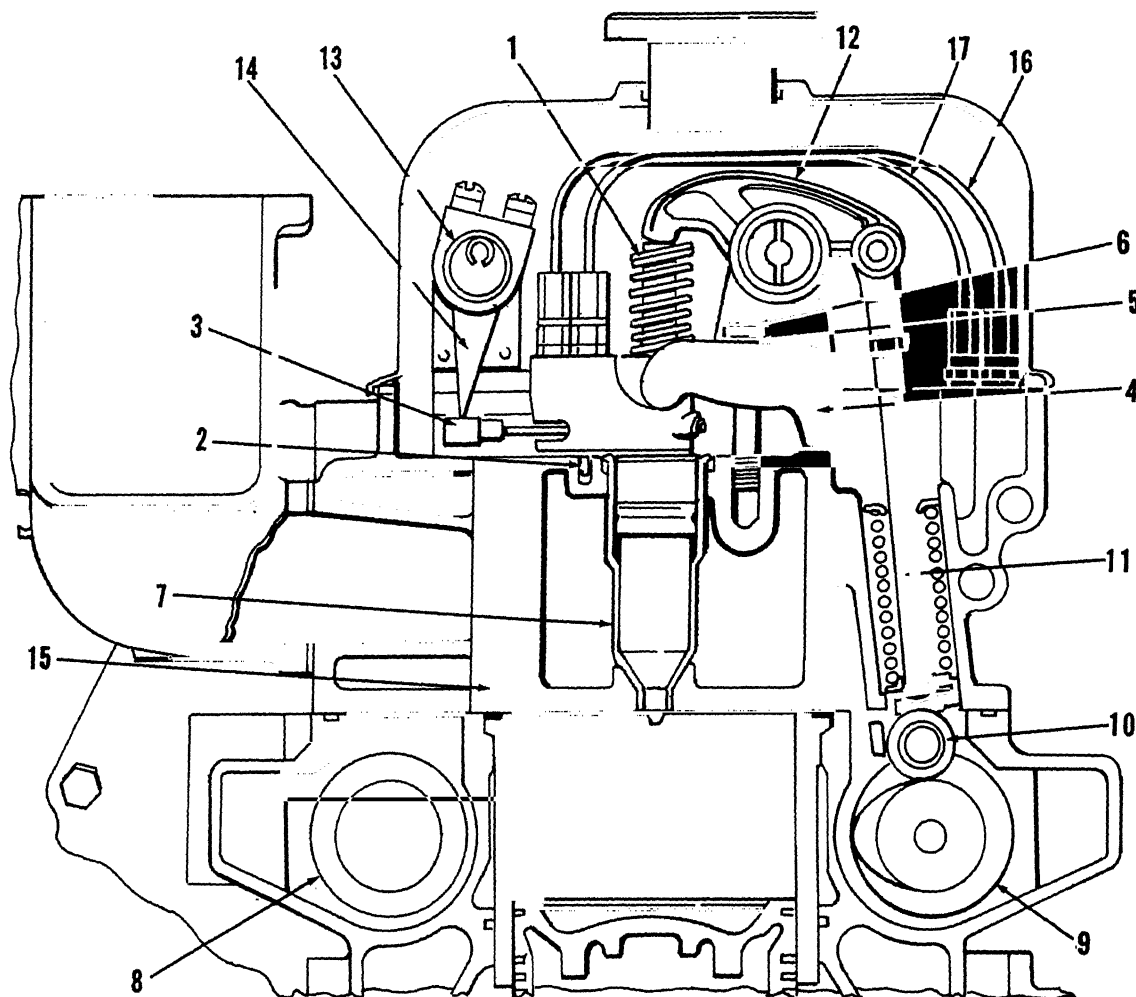
d. Remove the two rocker shaft bracket bolts and swing the rocker arms away from the injectors and valves.

e. Remove the injector clamp bolt, special washer and clamp.

f. Loosen the inner and outer adjusting screws on the injector rack control lever and slide the lever assembly away from the injector.

g. Lift the injector from its seat in the cylinder head.

h. Cover the injector hole in the cylinder head to prevent dirt or foreign material from entering the engine.



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Figure 3-13. Fuel injector mounting.

3-63. Disassembly

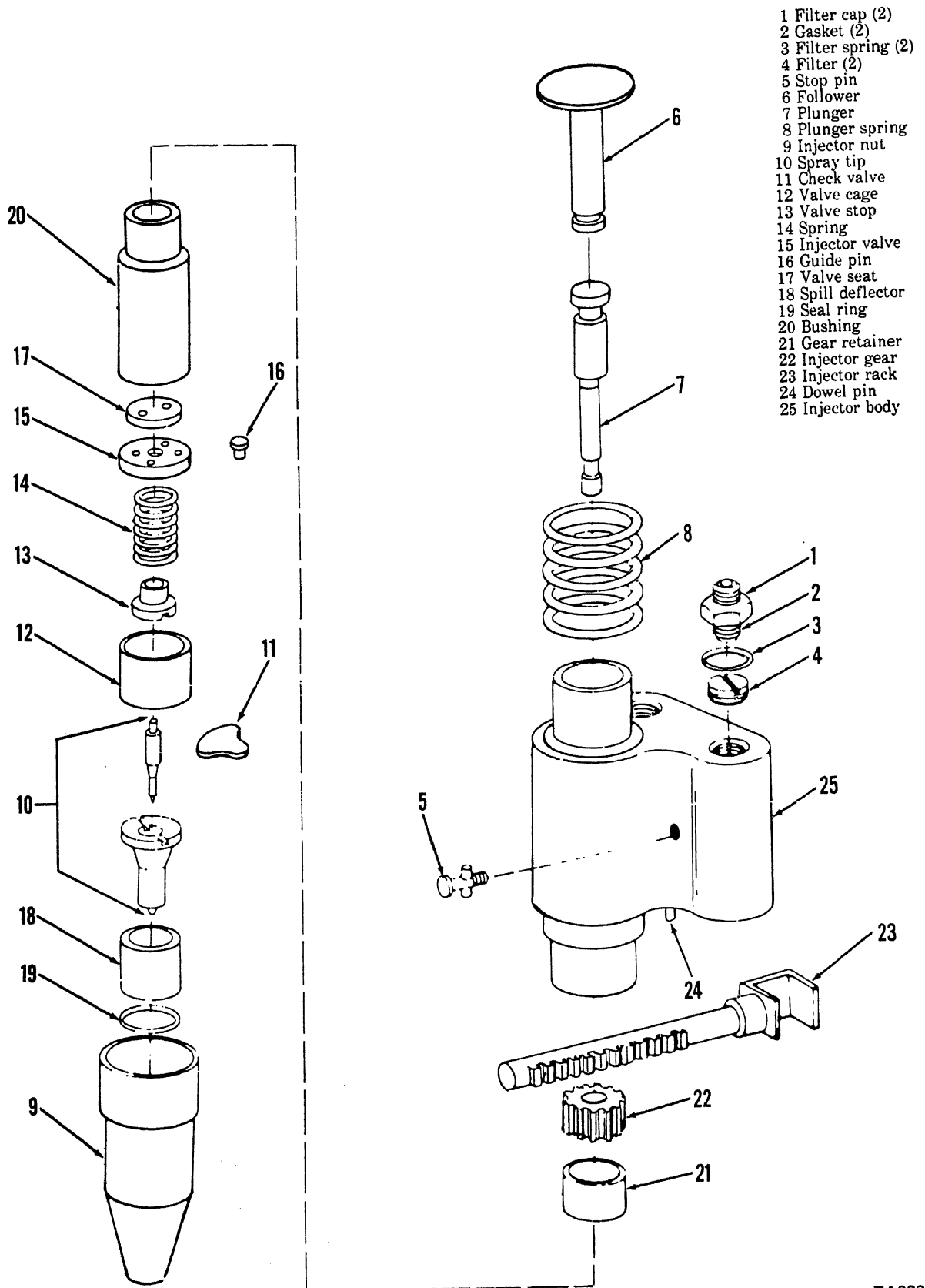
a. Refer to figure 3-14. Set the injector in an upright position in a suitable holding device and remove filter caps (1), gaskets (2), springs (3) and filters (4). Discard filters (4) and gaskets (2).

b. Compress the plunger spring with the heel of the hand, and, at the same time raise the base of the spring with a screwdriver until stop pin (5) can be removed. Allow the spring to rise gradually.

c. Invert the injector and remove follower (6), plunger (7), and plunger spring (8) as an assembly.

d. With the injector in the inverted position, loosen injector nut (9). Lift the nut straight up, being careful not to dislodge the spray tip and valve parts.

e. Remove spray tip (10), check valve (11), valve cage (12), valve stop (13), spring (14), injector valve (15), guide pin (16) and valve seat (17).



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Figure 3-14. Fuel injector assembly—exploded view.

- f. Remove spill deflector (18) and seal ring (19) from the injector nut.
- g. Remove bushing (20), gear retainer (21), gear (22), and rack (23) from the injector body.
- h. Withdraw dowel (24) from injector body (25).

3-64. Inspection and Repair

- a. Clean all parts in cleaning solvent, Federal Specification P-D-680, or equivalent, before inspection.

NOTE

Since most injector difficulties are the result of dirt particles, it is essential that a clean area be provided on which to place injector parts after cleaning and inspection. Do not use waste or rags for cleaning purposes.

- b. Be sure all passages, drilled holes and slots are clean.
- c. Discard filters, seals and gaskets.

CAUTION

Care must be taken not to ream spray tip oversized.

- d. Clean spray tip (10) with a suitable reamer to remove carbon deposits. Clean spray tip orifices with a suitable cleaning wire. Before using the wire, hone the end of the wire to remove all sharp edges and burrs. Taper the end of the wire a distance of one-sixteenth of an inch.

- e. The exterior surface of the spray tip may be cleaned with a brass wire buffing wheel.

NOTE

When handling the injector plunger, do not touch the finished plunger surfaces with your fingers. Wash the plunger and bushing with clean fuel oil and dry them with compressed air.

- f. Be sure the high pressure bleed hole in the side of the bushing is not plugged. If the hole is plugged, fuel leakage will occur at the upper end of the bushing, where it will drain from the injector rack and vent holes, and can cause serious lubrication dilution problems.

NOTE

Keep the plunger and bushing together because they are mated parts. Replace only as a set.

- g. Inspect the teeth on the control rack and the control rack gear for excessive wear and damage. Also check for wear and damage in the bore of the gear and inspect the gear retainer. Replace worn or damaged parts.

- h. Clean and brush all passages in the injector body. Blow out passages with compressed air.

- i. Carefully ream the injector nut, being careful not to remove metal or set up burrs.

- j. Carefully ream the injector body. After a few turns, remove the reamer and check the face of the ring bore for reamer contact over the entire face of the ring.

Repeat reaming if necessary. Clean the opposite end of the ring in the same manner.

- k. Inspect the injector follower and pins for wear.

- l. Inspect both ends of the spill deflector for sharp edges or burrs that could create burrs on the injector body or nut and cause particles of metal to be carried into the spray tip and valve parts. Remove burrs with a 500 grit stone.

- m. Inspect the follower spring for defects.

- n. Check the seal ring areas on the injector body for burrs or scratches. Check the surface which contacts the injector bushing for scratches, scuff marks or other damage. If necessary, lap this surface.

- o. Inspect the injector plunger and bushing for scoring, erosion, chipping or wear. Check for sharp edges on that portion of the plunger that rides in the gear. Remove any sharp edges with a 500 grit stone. Wash the injector after it has been stoned. Slip the plunger into the bushing and check for free movement. Replace bushing and plunger as an assembly if any of the above damage is noted.

- p. Examine the spray tip seating surface of the injector nut for nicks, burrs or brinelling. Reseat the surface or replace the nut if it is severely damaged.

- q. The injector valve spring is important in establishing the valve opening pressure. Replace a worn or damaged spring.

- r. Inspect the sealing surfaces of the spray tip and valve parts. Examine the sealing surfaces with a magnifying glass for even the slightest imperfections. Check for burrs, nicks, cracks, chipping and excessive wear. Also check for enlarged orifices in the spray tip. Replace damaged or excessively worn parts.

- s. Before reinstalling used valve parts in an injector, lap all of the sealing surfaces indicated below. After lapping, minimum thicknesses should be as follows:

Spray tip (shoulder)	0.121 inch
Injector valve	0.073 inch
Valve cage	0.490 inch
Valve seat	0.124 inch
Check valve	0.027 inch

- t. After lapping is complete, clean all lapped parts in clean fuel oil and blow dry with compressed air.

3-65. Reassembly

- a. Refer to figure 3-14. Hold the injector body right side up and place a new filter (4), slot side up, in each of the fuel cavities. Install springs (3) and gaskets (2). Lubricate the threads and install caps (1), tightening the caps to 65—75 ft-lb (88—102 N · m).

- b. Purge the filters with compressed air blown through the filter caps. Install clean shipping caps on the filter caps to prevent dirt or foreign material from entering the fuel cavities.

- c. Hold the injector body, bottom end up, and slide rack (23) through the hole in the body. Look into the bore for the rack teeth. Then move the rack until the

drill marks on the teeth are visible. Hold the rack in this position.

d. Place gear (22) in the injector body so that the marked tooth on the gear is engaged between the two marked teeth on the rack.

e. Place gear retainer (21) on top of the gear. Then align guide pin (16) in bushing (20) with the slot in the injector body. Slide the end of bushing (20) into position.

f. With the injector body in the same position, place a new seal ring (19) on the shoulder of the body. Then slide spill deflector (18) over the barrel of the bushing.

g. Place valve seat (17) on the end of the bushing. Insert the stem of valve (15) in one end of valve spring (14) and valve stop (13) in the other end of the valve. Lower valve cage (12) over this assembly so that the valve stop (13) seats in the cage. Place the valve cage assembly on the valve seat.

h. Locate check valve (11) centered on the cage and place spray tip (10) over the check valve and against the valve cage.

i. Lubricate the threads of injector nut (9) and carefully thread the nut on the injector body by hand. Rotate the spray tip with the fingers while threading the nut on the body. Tighten the nut as tight as possible by hand. There should be sufficient force on the spray tip to make it impossible to rotate the tip by hand. Then tighten the injector nut to 55—65 ft-lb (75—88 N · m).

NOTE

Do not exceed the specified torque or the nut may stretch.

j. Install dowel pin (24) into the injector body.

k. Hold the injector right side up and push the rack all the way in. Then place spring (8) into position.

l. Place stop pin (5) on the injector body so that the tighter wound end of spring (8) rests on the narrow flange of the stop pin.

m. Align the slot in follower (6) with the stop pin in the injector body. Next, align the flat side of plunger (7) with the slot in the follower. Then insert the free end of the plunger in the injector body. Press down on the follower and at the same time press the stop pin (5) into position.

n. Check the spray tip concentricity. If the total run out exceeds 0.008 inch, loosen the injector nut, center the spray tip, and tighten the nut to 55—65 ft-lb (75—88 N · m). If, after several attempts, the spray tip cannot be positioned properly, replace the injector nut.

3-66. Installation

a. Refer to figure 3-13. Be sure the injector is filled with fuel oil. Insert the injector into the injector tube with the dowel located in the locating hole in the cylinder head.

b. Slide the rack control lever over so that it registers with the injector rack.

c. Install the injector clamp, special washer and bolt. Tighten the bolt to 20—25 ft-lb (27—34 N · m). Be sure that the clamp does not interfere with the injector follower spring or the exhaust valve springs. Check the injector control rack for free movement.

d. Move the rocker arm assembly into position and secure the rocker arm brackets to the cylinder head.

e. Be sure the exhaust valve bridges are installed properly, as discussed in paragraph 4-9.

f. Install the fuel lines.

CHAPTER 4 REPAIR OF CRANE ENGINE

Section I. GENERAL

4-1. Description

The crane engine is a 4-cylinder, in-line, Detroit Diesel Series 53 engine.

4-2. Engine Removal

Refer to paragraph 2-12 and remove the engine from the crane. Install the engine on a suitable stand for ease of disassembly.

4-3. Removal of Accessories

a. Refer to TM 5-3810-295-12 and chapter 3 of this manual and remove the following accessories from the engine.

- (1) Oil filters and lines.

- (2) Oil cooler.
- (3) Generator.
- (4) Starting motor.
- (5) Water pump.
- (6) Air inlet housing.
- (7) Air blower.
- (8) Fuel pump and fuel lines.
- (9) Engine governor.
- (10) Tachometer drive.

b. Parts removed from the engine should be stored together so they will be available for reassembly. Items that have machined faces, which could be damaged, should be stored on wooden blocks, racks or parts dolly.

Section II. CYLINDER HEAD, ROCKER ARMS AND VALVES

4-4. Description

The cylinder head is a one-piece casting, bolt mounted on top of the cylinder block. The cylinder head may be removed as a single assembly containing the cam followers, cam follower guides, rocker arms, exhaust valves, and injectors.

4-5. Removal

a. Refer to figure 4-1. Remove exhaust manifold by removing nuts (1), washers (2), manifold (3) and gasket (4). Remove pipe plug (5) from the manifold.

b. Remove rocker arm cover screws (6), cover (7) and gasket (8). Refer to paragraph 3-62 and disconnect and remove injector controls, bracket and fuel rod.

c. Remove fuel pipes (9), adapters (10) and adapter washers (11). Cover fuel openings in the fuel manifold and injectors to prevent dirt and foreign material from entering the fuel system.

d. Crank the engine to bring the outer ends of the push rods on the injector and valve rocker arms in line horizontally. Remove rocker arm shaft bracket bolts (12) and swing the rocker arms away from the injectors and valves.

e. Remove injector clamp screws (13), washers (14) and clamps (15). Remove injectors (16).

f. Remove cylinder head bolts (17). Install lifting brackets and remove head from the cylinder head on the work bench, be sure to protect the cam follower rollers and the injector spray tips by resting the valve side of the head on 2-inch-thick blocks of wood.

4-6. Disassembly

a. Refer to figure 4-1. Remove gasket (18), compression gaskets (19) from individual cylinders, and seal rings (20), (21) and (22).

b. Lift the rocker arm and bracket assemblies from the cylinder head. Loosen lock nut (23) and separate the push rod assembly from the rocker arms.

c. Remove retainer (24), spring seat (25), push rod spring (26), spring seat (27) and push rod (28).

d. Remove clevis pins (29), bushings (30) and (31), and clevis (32). Remove bridge pins (33) and bridges (34).

e. Slide shaft brackets (35) from shaft (41). Remove rocker arms (36), (37) and (38). Remove bushings (39) and shaft plugs (40) from shaft (41).

f. Compress springs (44) and remove lock halves (42). Remove caps (43), springs (44) and valve seats (45).

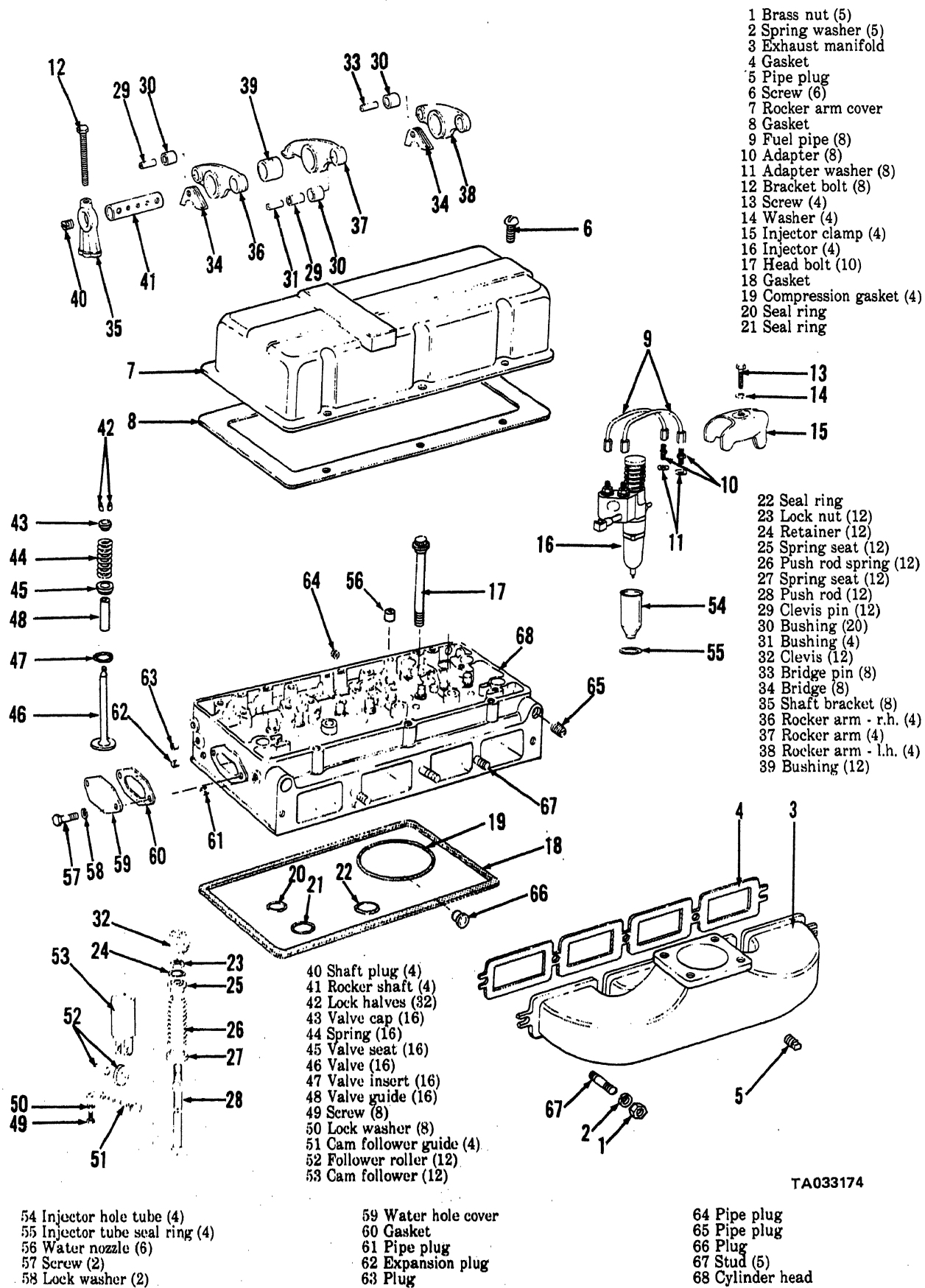
g. Turn the cylinder head over and remove valves (46). Remove inserts (47) and guides (48).

NOTE

Mark valves so that they can be installed in the same relative locations.

h. Remove screws (49) and lock washers (50). Remove cam follower guides (51) and rollers (52), and cam followers (53) as an assembly. Disassemble by driving the roller pin from the guide.

i. Press injector hole tube (54) from the cylinder head, pressing from the bottom of the head. Remove injector hole seal ring (55).



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Figure 4-1. Cylinder head, rocker arms, and valves—exploded view.

j. Remove water nozzles (56) from the head. Remove screws (57) and lock washers (58) and separate water hole cover (59) from the head. Remove gasket (60).

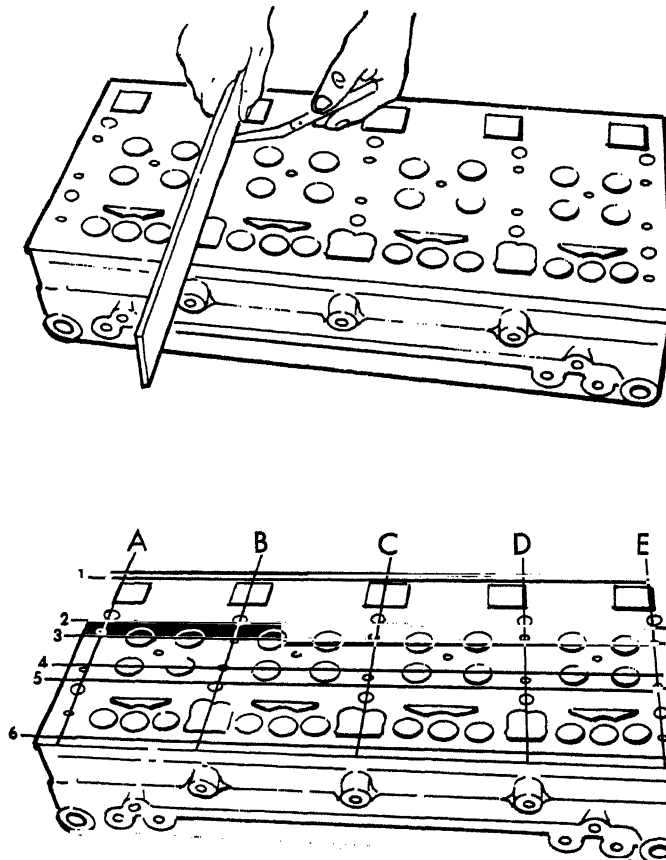
k. Remove pipe plug (61), expansion plug (62) and plug (63). Remove plugs (64), (65) and (66). Remove studs (67) from head (68).

4-7. Cleaning, Inspection and Repair

a. Clean all parts with cleaning solvent, Federal Specification P-D-680, or equivalent before inspecting. Replace all seals and gaskets.

b. Clean cylinder head thoroughly with steam and clean all ports and openings with a soft bristle brush.

c. Inspect cylinder head for warpage and damage. Use an accurate straight-edge and feeler gage to check for transverse warpage at each end and between cylinders. Also check for longitudinal warpage in at least six places, as shown in figure 4-2. Maximum longitudinal warpage is 0.006 inch. Maximum transverse warpage is 0.004 inch.



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Figure 4-2. Checking bottom face of cylinder head for warpage.

d. The face of the cylinder head may be refaced, although not in excess of 0.20 inch. The distance from the top of the head to the face should not be less than 4.376 inches.

NOTE

After resurfacing the cylinder head face, always stamp the amount of stock removed on the face of the head near the outer edge of the head in an area not used as a sealing surface.

e. Inspect the cam follower bores for scoring or wear. Light score marks may be cleaned up with crocus cloth wet with fuel oil. If the bores are excessively worn so that the cam follower to head clearance exceeds 0.006 inch, replace the cylinder head.

f. Check the cylinder head for leaks as follows.

(1) Install injector hole tubes (54) and injector tube seal rings (55) in the cylinder head.

(2) Seal off the water holes in the head with steel plates and suitable rubber gaskets held in place with bolts.

(3) Install dummy or scrap injectors to insure seating of the injector tubes. (Dummy injectors may be made from scrap nuts and bodies.)

(4) Drill and tap into one of the temporary water hole plates for an air hose connection and apply 80 to 100 psi pressure with the head immersed in a tank of water heated to 180° to 200°F., for a period of 20 minutes. Observe for air bubbles which indicate leaks or cracks.

(5) Replace the head if cracks are evident. Replace any leaking fuel injector tubes.

g. Inspect valve seat inserts for cracks or burning.

h. Inspect the rounded ends of the push rods for wear. Replace any push rod that is worn or bent.

i. Check the push rod springs and replace the springs when a load of less than 250 pounds compresses the springs to a length of 2 $\frac{3}{4}$ inches.

j. Replace all pitted or fractured valve springs.

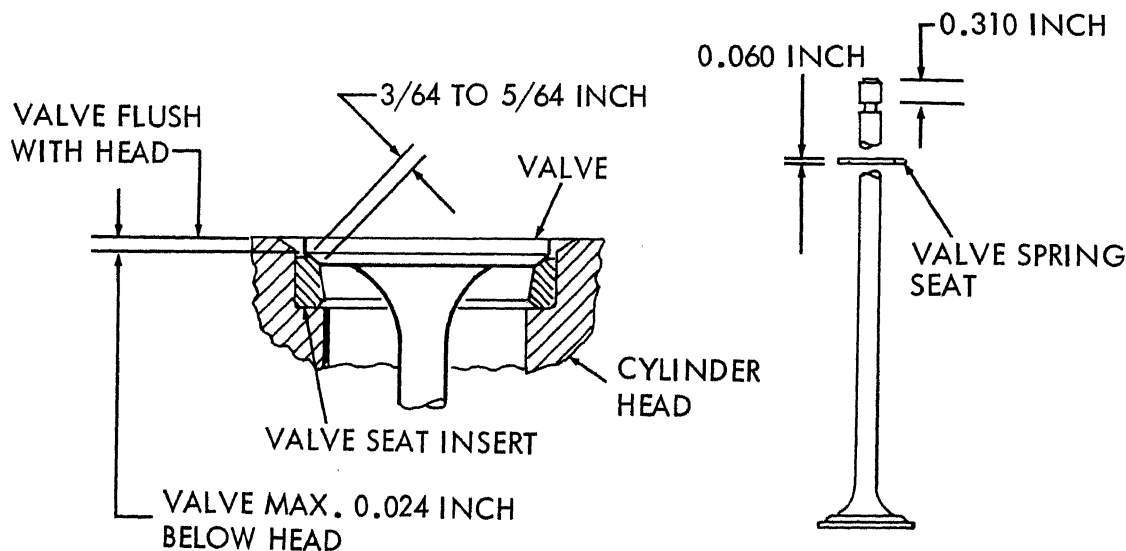
k. Check the valve springs on an accurate spring tester. Replace any spring that compresses to 1.93 inches under a load of 25 pounds. The difference in load between a pair of springs must not exceed 6 pounds or the valve bridge will be unbalanced.

l. Inspect valve caps and spring seats for wear. Replace worn or damaged parts.

m. Clean carbon from the valve stems and wash the valves in cleaning solvent. Check the valve stems for scratches and scuff marks, and inspect the valve races for ridges, cracks or pitting. If valve heads are warped, replace the valves. Valves may be refaced. However, to provide sufficient valve strength and spring tension, the edge of the valve at the valve head must not be less than one thirty-seconds of an inch and must be within the specifications shown in figure 4-3. The angle of the valve face, and the valve seat insert, must be exactly 30 degrees.

NOTE

Valve seat inserts must be ground in place in the cylinder head.



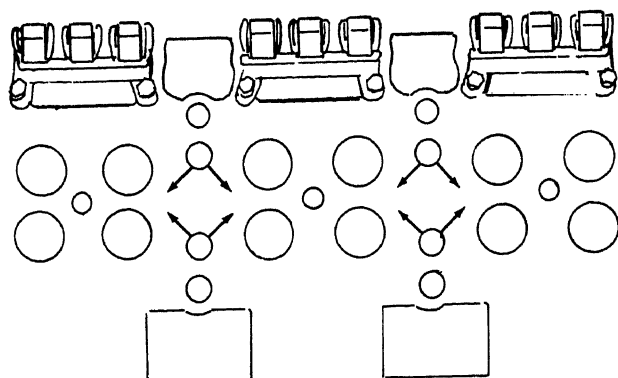
TA033176

Figure 4-3. Exhaust valve installation specifications.

n. Inspect valve guides for fractures, scoring or excessive wear. Check valve-to-guide clearance. If clearance exceeds 0.005 inch, replace the valve guides.

4-8. Reassembly

a. Refer to figure 4-1. Install water nozzles (56) in the cylinder head. Be sure the ports in the bottom of the head are positioned as shown in figure 4-4.



TA033177

Figure 4-4. Water nozzle installation.

b. Position the cylinder head right side up on wooden blocks. Position valve guides (48) squarely in the bore in the cylinder head. Gently press the guides in until the top of the guide is 0.010 to 0.040 inch below the top of the head.

c. Immerse the cylinder head in water heated to 180° to 200°F. for at least 30 minutes. With the head resting bottom side up on a bench, quickly place the valve seat inserts (47) into the counterbores in the cylinder head face. Drive the inserts in place until they are firmly seated in the head.

d. If an old insert is to be refaced, or if a new insert is installed, the work must be done with a grinding wheel, using the eccentric grinding method. Use the following procedure:

- (1) Apply a 30° grinding wheel on the valve insert.
- (2) Use a 60° grinding wheel to open the throat of the insert.
- (3) Grind the top surface with a 15° wheel to narrow the width of the seat from three sixty-fourth to five sixty-fourths of an inch. (Refer to fig. 4-3.)

CAUTION

Do not allow the grinding wheel to contact the cylinder head while grinding the insert. If necessary, replace the insert.

(4) Check the concentricity of each valve seat insert relative to the valve guide with a dial indicator. If runout exceeds 0.002 inch, check for a bent valve guide before regrounding the insert.

(5) Apply a light coat of Prussian Blue to the valve seat insert. Lower the stem of the valve in the valve guide and bounce the valve on the seat. Do not rotate the valve. This procedure will show the area of contact on the valve face. The most desirable area of contact is at the center of the valve face.

e. Before installing valves (46), check to see that the valves are within specifications shown in figure 4-3. Lubricate the valve stems with engine oil and slide the valves all the way into the guides.

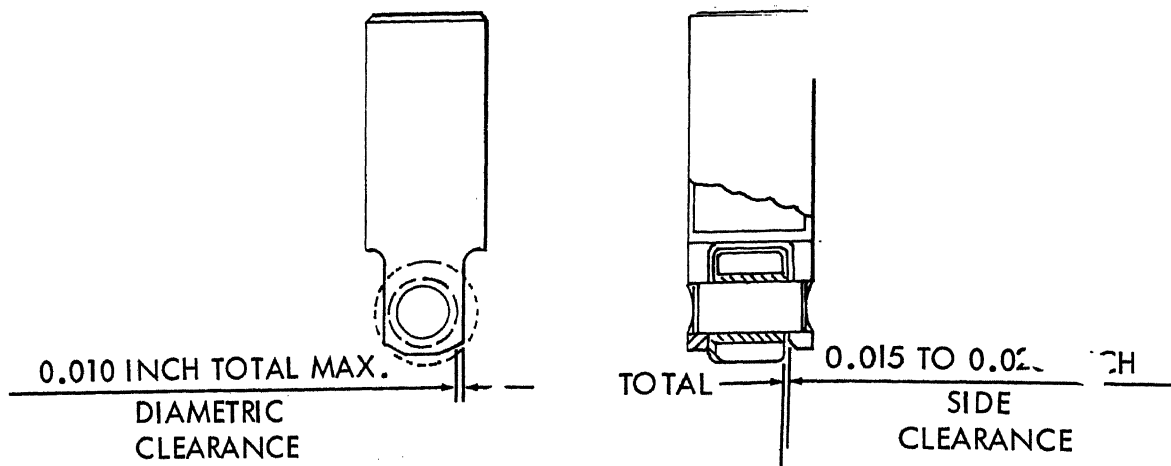
NOTE

If reconditioned valves are used, be sure they are installed in the same relative locations from which they were removed.

f. Hold the valves in place temporarily with a strip of masking tape. Turn the head right side up on the work bench, and place a board beneath the head to support the valves. Install valve springs (44), seats (45) and caps (43).

g. Compress the valve springs and install valve locks (42). Check the position of the valve against the specifications shown in figure 4-3. Using a spring checking gage, note the gage reading at which the exhaust valve begins to open. The minimum pressure required to start the valve to open must not be less than 25 pounds (34 N · m).

h. Assemble cam follower roller (52) and cam follower (53). The cam follower roller must roll smoothly and freely on its pin, and the roller must be free from flat spots and scuff marks. Check roller clearances as shown in figure 4-5.



TA033178

Figure 4-5. Cam roller clearance specifications.

i. Install lower spring seats (27) on each push rod (28). Place push rod springs (26).

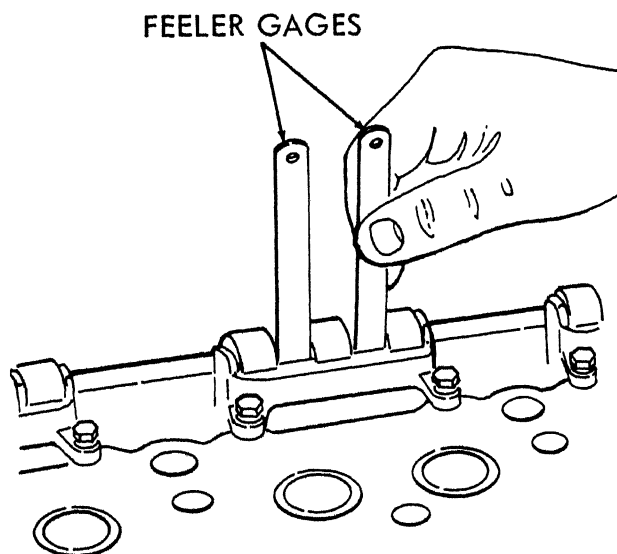
j. Install spring seat retainers (24) in the cylinder head. Slide the push rod, spring, and seat assemblies into the cam follower bores from the bottom of the cylinder head.

k. Screw the push rod lock nuts (23) down on the upper end of the push rods as far as possible. Then screw the push rods into clevis (32) until the end of the rod is flush with or above the inner side of the clevis.

l. Immerse the cam follower assemblies (53) in clean engine oil heated to 100° to 125° F. for at least one hour. This will insure lubrication between the cam follower roller pins and the roller bushings. Rotate the cam follower roller during the soaking period to purge any air from the bushing-roller area.

m. Note the oil hole in the bottom of the cam follower. With this oil hole pointing away from the exhaust valves, slide the cam follower assembly (53) into position from the bottom of the head.

n. Attach the cam follower guides (51) to the bottom of the cylinder head. Secure the guides with screws (49) and lock washers (50). Tighten screws (49) to 12–15 ft-lb (16–20 N·m). Check to be sure there is at least 0.005-inch clearance between the cam follower and the cam follower guide. (Refer to fig. 4-6.) If there is not enough clearance, loosen the screws slightly and tap each corner of the guide with a brass rod. Retighten the screws and recheck the clearance.



TA033179

Figure 4-6. Checking clearances between cam followers and cam follower guides.

o. Install exhaust manifold studs (67). Install pipe plug (61), expansion plug (62), plugs (63), (64), (65) and (66). Install new gasket (60) and cover (59). Secure

cover (59) with lock washers (58) and screws (57).

p. Install injectors (16). Be sure dowels in the injector body line up with alignment holes in the cylinder head.

q. Lightly install injector clamps (15) and secure with screws (13) and washers (14). Be sure clamps do not interfere with the injector follower spring or the exhaust valve springs. Tighten the injector clamp screws (13) to 20–25 ft-lb (27–34 N · m).

r. Assemble bushings (39) and rocker arms (36), (37) and (38) on rocker shafts (41). Install shaft plugs (40). Lubricate all rocker arm parts with engine oil before assembly.

s. Install rocker arm brackets (35) on the shaft and place the assemblies into position on the head. Install bracket bolts (12) but do not tighten the bolts at this time.

t. Install bushing (31), bushings (30) and clevis pins (29). Install bridges (34) and secure with bushings (30) and bridge pins (33).

4-9. Installation

a. Refer to figure 4-1. Be sure tops of pistons are clean and free of foreign material. Be sure that each push rod is threaded into the clevis until the end of the push rod projects through the clevis. Be sure that the groove and counterbores in the top of the cylinder block are clean and smooth.

b. Install a new compression gasket (19) on each cylinder liner. Place new seal rings (20), (21) and (22) in the counterbores of the water and oil holes in the cylinder block. Install a new gasket (18) in the milled groove on the cylinder block.

c. Install the head assembly on the cylinder block without disturbing the gaskets and seals. Use appropriate guide studs on each end of the block to assist in aligning the head.

NOTE

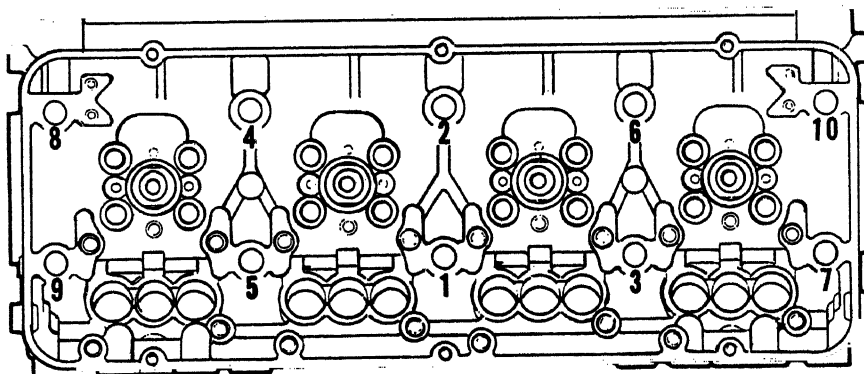
Make a final visual inspection that the gaskets and seals are in place before lowering the cylinder head on the block. Compression gaskets and seals jarred or shifted out of place will cause leaks and blow by with poor engine performance.

d. Install head bolts (17). Begin on the camshaft side of the head to take up tension in the cam follower springs by tightening the bolts lightly. Finally tighten the bolts to 170–180 ft-lb (230–244 N · m), about one-half turn at a time, in the sequence shown in figure 4-7.

NOTE

Cover the oil drain holes in the cylinder head to prevent dirt and foreign material from entering the holes.

e. Tighten rocker arm bracket bolts (12) to 50–55 ft-lb (68–75 N · m).



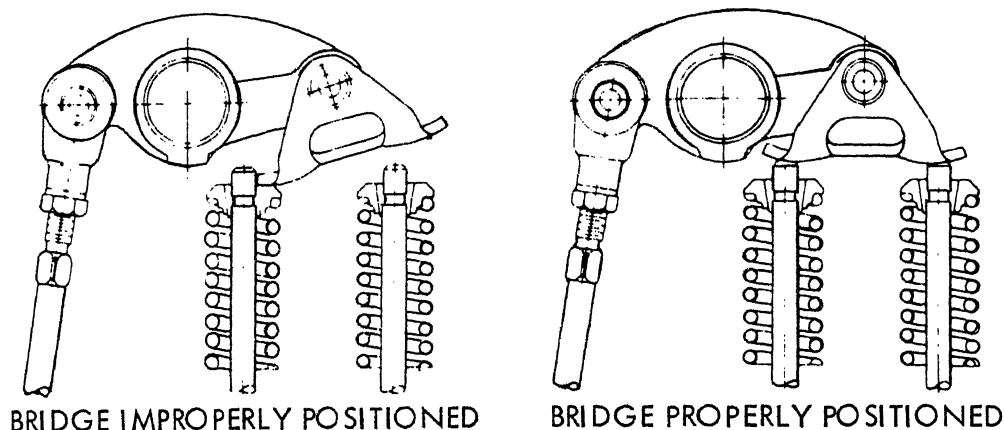
TA033180

Figure 4-7. Head bolt tightening sequence.

CAUTION

It is possible to damage the exhaust valves if the valve bridges are not resting on the ends

of the exhaust valves when tightening the rocker arm bracket bolts. Refer to figure 4-8.



TA033181

Figure 4-8. Bridge positioning.

f. Align fuel pipes (9) and install the fuel pipes, adapters (10) and washers (11). Tighten the fuel pipe connections to 12–15 ft-lb (16–20 N·m).

g. Set the injector control tube shaft (refer to para 3-62) in place on the cylinder head. Tighten the bolts hand tight. Be sure that the ball end of each injector rack engages the slot in the corresponding injector control rack. Install the control tube shaft in accordance with instructions given in paragraph 3-62.

h. Remove covers from the oil drain holes. Install gasket (8), cover (7) and secure with screws (6).

i. Install gasket (4), exhaust manifold (3) and secure with nuts (1) and washers (2). Install plug (5) in the manifold.

j. Adjust the engine exhaust valves as follows.

CAUTION

It is important that the valves be adjusted cold before the engine is started after the valves have been removed or replaced. Failure to perform this procedure could result in damage to the valves. All of the exhaust

valves must be adjusted, in firing order sequence, during one full revolution of the crankshaft.

(1) Place the engine governor in the idle speed, or no fuel position.

(2) Rotate the crankshaft until the injector follower is fully depressed on the cylinder to be adjusted.

(3) Loosen the push rod lock nut. Place a 0.027-inch feeler gage between the end of one valve stem and the rocker arm bridge. Adjust the push rod to obtain a smooth pull on the feeler gage.

(4) Remove the feeler gage. Hold the push rod with a wrench and tighten the lock nut.

(5) Recheck the clearance. If the adjustment is correct, the 0.025-inch feeler gage will pass freely between the end of one valve stem and the rocker arm bridge. The 0.027-inch feeler gage will not pass through. Readjust the push rod if necessary.

k. Refer to TM 5-3810-295-12 for hot valve adjustment.

Section III. REPAIR OF FLYWHEEL

4-10. Description

The flywheel is attached to the rear of the crankshaft. Its purpose is to oppose and moderate, by its inertia, any speed fluctuations in the speed of the engine.

4-11. Removal

a. Refer to paragraph 2-13 and remove the reduction gear from the flywheel.

b. Refer to figure 4-9. Remove attaching screws (1) and retainer plate (2) while holding the flywheel in position by hand. Reinstall one screw (1).

c. Attach an appropriate lifting tool to the flywheel using two $\frac{3}{8}$ -inch screws. Attach a suitable chain hoist to the lifting tool.

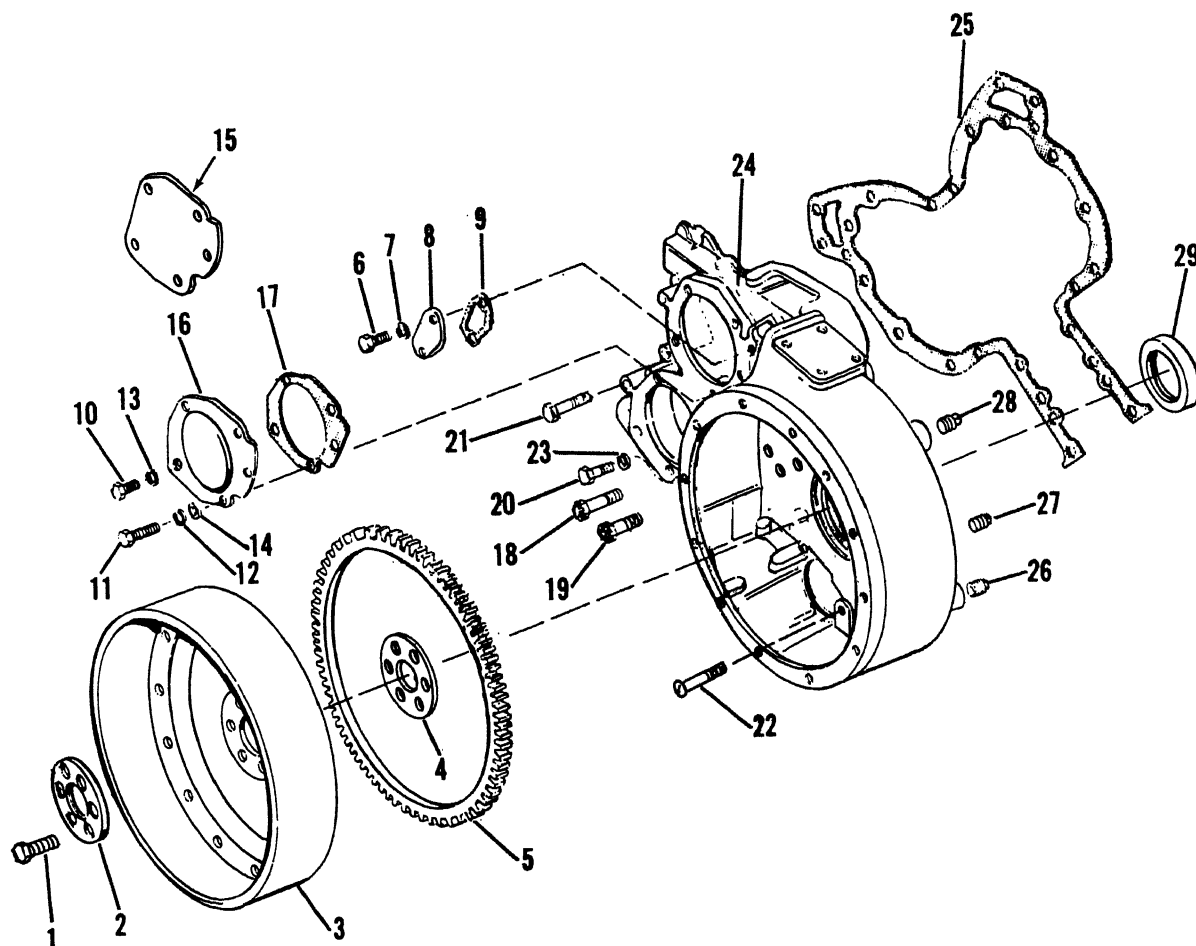
d. Remove the remaining screw (1). Move the upper end of the flywheel back and forth until the flywheel is loosened. Withdraw flywheel (3) and shim (4).

4-12. Disassembly

a. Refer to figure 4-9. Support the flywheel, crankshaft side down, on a solid flat surface or a hardwood block that is slightly smaller than the inside

diameter of the ring gear. Note the chamfer on the gear teeth so that the new gear may be installed in the same position.

b. Drive ring gear (5) from the flywheel with a suitable drift and hammer. Work around the periphery of the flywheel to avoid binding the gear on the flywheel.



TA033182

1 Screw
2 Retainer plate
3 Flywheel
4 Shim
5 Ring gear
6 Screw
7 Lock washer
8 Access cover
9 Cover gasket
10 Screw

11 Screw
12 Lock washer
13 Flat washer
14 Flat washer
15 Cover
16 Cover
17 Cover gasket
18 Screw
19 Screw

20 Screw
21 Screw
22 Screw
23 Lock washer
24 Flywheel housing
25 Housing gasket
26 Pipe plug
27 Pipe plug
28 Pipe plug
29 Oil seal

Figure 4-9. Flywheel assembly—exploded view.

c. Refer to paragraph 4-33 and remove the oil pan.

d. Remove screws (6), lock washers (7), covers (8) and gaskets (9). Remove screws (10) and (11), lock washers (12) and flat washers (13) and (14). Remove covers (15) and (16), and gasket (17).

e. Remove screws (18), (19), (20), (21) and (22), and

lock washers (23). Note the location of the various size screws so they may be reinstalled in their proper locations.

f. Thread two pilot studs into the cylinder block to guide the flywheel housing until the oil seal clears the end of the crankshaft. Thread eye bolts into the pads on

top of the housing, and attach a chain hoist with a suitable sling to prevent the housing from falling.

g. Strike the front face of the housing alternately on each side of the engine with a soft hammer to loosen the housing. Remove flywheel housing (24) and gasket (25).

h. Remove pipe plugs (26), (27), and (28). Press oil seal (29) from the housing.

4-13. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent, before inspection.

b. Replace all seals and gaskets.

c. Inspect the flywheel housing for cracks or any other damage. Replace housing if it is damaged.

d. Check flywheel face for signs of cracks, scoring or overheating.

e. Inspect flywheel ring gear for signs of cracks or missing teeth.

4-14. Reassembly

a. Refer to figure 4-9. Support the inner face of flywheel housing (24) in an arbor press. Apply a non-hardening sealant to the periphery of the metal casing.

b. Apply GAA grease to the lip of oil seal (29). Position the seal in the flywheel housing bore with the lip of the seal pointing toward the inner face of the housing.

c. Press the oil seal into the flywheel housing until the seal is flush with the outside face of the housing. Remove all excess sealant from the housing and seal.

d. Install plugs (26), (27) and (28). Lubricate gear train teeth with clean engine oil.

e. Affix a new gasket (25) to the rear end plate. Apply a thin film of grease on shim (4) and affix the shim to the rear end plate.

f. Apply a thin coat of grease to the rear crankshaft oil seal located in the flywheel housing. Install two pilot studs in the rear end plate to guide the housing into place without damaging the oil seal.

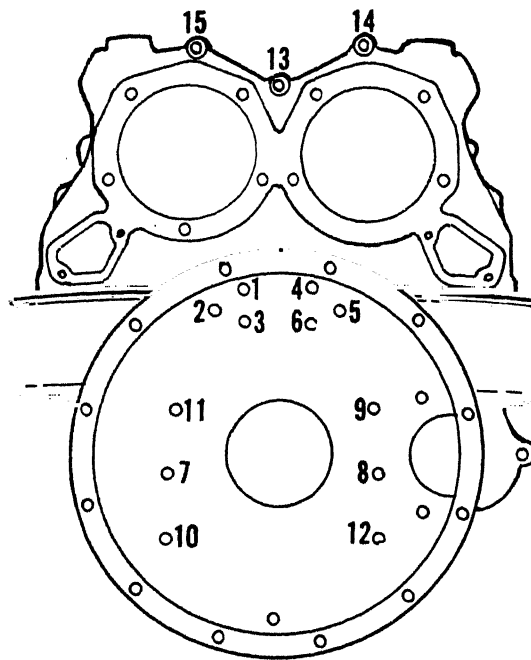
g. Using a suitable sling and chain hoist, install flywheel housing (24) against the gasket and rear end plate.

h. Install the flywheel mounting screws (18), (19), (20), (21) and (22) and washers (23). Finger tighten the screws.

i. Refer to figure 4-10 and draw the mounting screws up snug in the sequence shown.

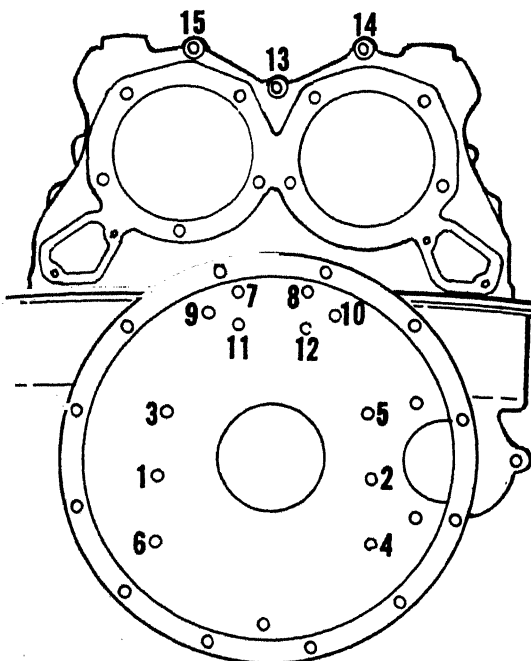
j. Refer to figure 4-11 for the final screw tightening sequence and tighten as follows:

Tighten the $\frac{5}{16}$ -inch screws (numbers 11 and 12) to 19–23 ft-lb (26–31 N · m). Tighten the $\frac{3}{8}$ -inch screws (numbers 7 through 10) to 40–45 ft-lb (54–61 N · m). Tighten the remaining $\frac{3}{8}$ -inch screws to 25–30 ft-lb (34–41 N · m).



TA033183

Figure 4-10. Initial tightening sequence of flywheel housing screws.



TA033184

Figure 4-11. Final tightening sequence of flywheel housing screws.

k. Using two dial indicators, check run-out at 45° angles (8 readings) on the flywheel housing. The maximum total readings may not exceed 0.013 inch for either the bore or the face.

l. If run-out exceeds limits, remove the flywheel housing and check for dirt or foreign particles between the flywheel housing and the rear end plate.

m. Install covers (15) and (16), and gasket (17), and secure with screws (10) and (11), flat washers (13) and (14) and lock washers (12).

n. Install access covers (8) and gaskets (9). Secure with screws (6) and lock washers (7).

o. Support the flywheel, ring gear side up, on a solid flat surface.

p. Rest the ring gear on a flat metal surface. Heat the gear uniformly with an acetylene torch, keeping the torch moving around the gear to avoid hot spots.

CAUTION

Do not heat the ring gear over 400°F. Ex-

cessive heating may destroy the original heat treatment.

q. Using a pair of tongs, place ring gear (5) on flywheel (3) with the chamfer facing the same direction it did originally.

r. Tap the gear in place against the shoulder of the flywheel. If the gear does not readily tap into place, remove and reheat the ring gear.

4-15. Installation

a. Using a suitable lifting device, position the flywheel on the crank shaft.

b. Install retaining plate (2) and secure with screws (1). Tighten the screws to 110—120 ft-lb (149—163 N·m).

c. Mount a dial indicator on the flywheel housing and check the run-out of the flywheel. Maximum allowable run-out is 0.001 inch.

d. Refer to paragraph 2-13 and install the reduction gear.

Section IV. REPAIR OF UPPER FRONT COVER

4-16. Description

The upper front cover is mounted against the cylinder block at the front upper end of the engine. The camshaft and balance shaft oil seals are pressed into the cover.

4-17. Removal and Disassembly

a. Refer to TM 5-3810-295-12 and remove engine fan.

b. Remove flywheel housing as outlined in chapter 4, section III.

c. Wedge a clean rag between the cam and balance weights (gears) at the rear of the engine to prevent rotation of the camshaft and balance shaft.

d. Refer to figure 4-12 and remove nuts (1). Force the balance weight (2) off the end of each shaft.

e. Remove cover attaching screws (3) and (4), and lock washers (5). Gently tap the cover and remove cover (6), dowel (7) and gasket (8). Remove Woodruff key (9).

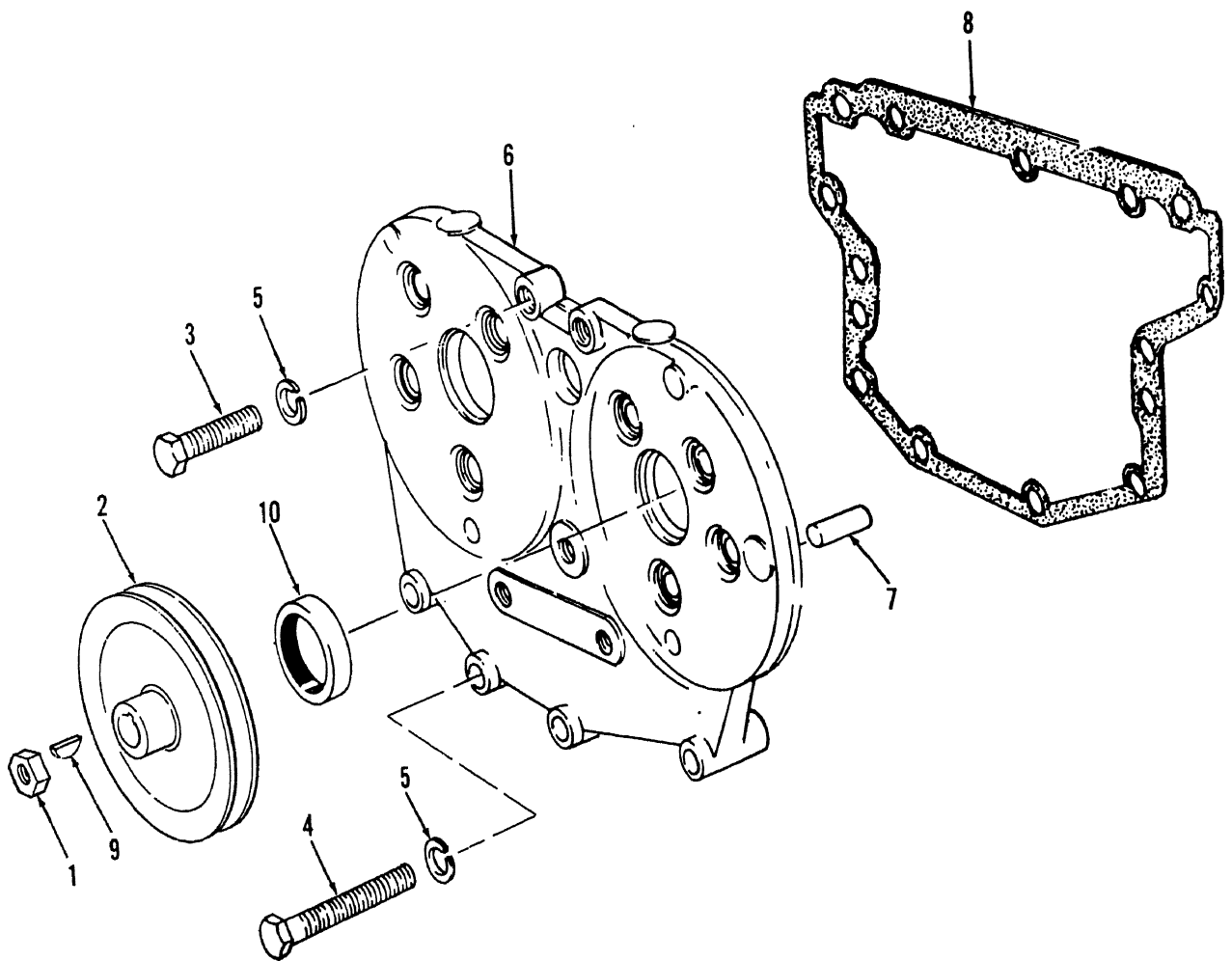
f. Remove oil seal (10).

4-18. Cleaning, Inspection and Repair

a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent, before inspection.

b. Replace seals and gaskets.

c. Inspect cover for cracks or damage. Replace damaged cover.



TA033185

- 1 Nut
- 2 Pulley
- 3 Screw
- 4 Screw
- 5 Lock washer
- 6 Cover
- 7 Dowel
- 8 Gasket
- 9 Woodruff key
- 10 Oil seal

Figure 4-12. Upper front cover assembly—exploded view.

4-19. Reassembly and Installation

a. Refer to figure 4-12. Support the inner face of the cover on wood blocks. Coat the bore of the cover with

r, and install

d. Install cover (6) on the cylinder block and secure with screws (3) and (4), and lock washers (5). Tighten the screws to 35 ft-lb (47 N · m).

e. Install Woodruff key (9) in each shaft. Align the keyway in the balance shaft with the key in the shaft. Slide pulley (2) on the shaft. If the weight does not easily slide onto the shaft, loosen the thrust washer retaining bolts at the opposite end of the shaft. Support the rear end of the shaft while tapping the weight into place with a hammer and sleeve. Install the other

weight on the cam shaft in the same manner.

f. Wedge a clean rag between the gears on the opposite end of the shafts. Install nuts (1) and tighten the nuts to 300—325 ft-lb (407—441 N · m).

g. Refer to chapter 4, section III, and install the flywheel housing.

h. Refer to TM 5-3810-295-12 and install the engine fan.

Section V. REPAIR OF FRONT COVER AND OIL PUMP

4-20. Description

The lower engine cover is mounted on the lower front portion of the crankcase. The cover contains the engine oil pump, which distributes lubricating oil throughout the engine under pressure.

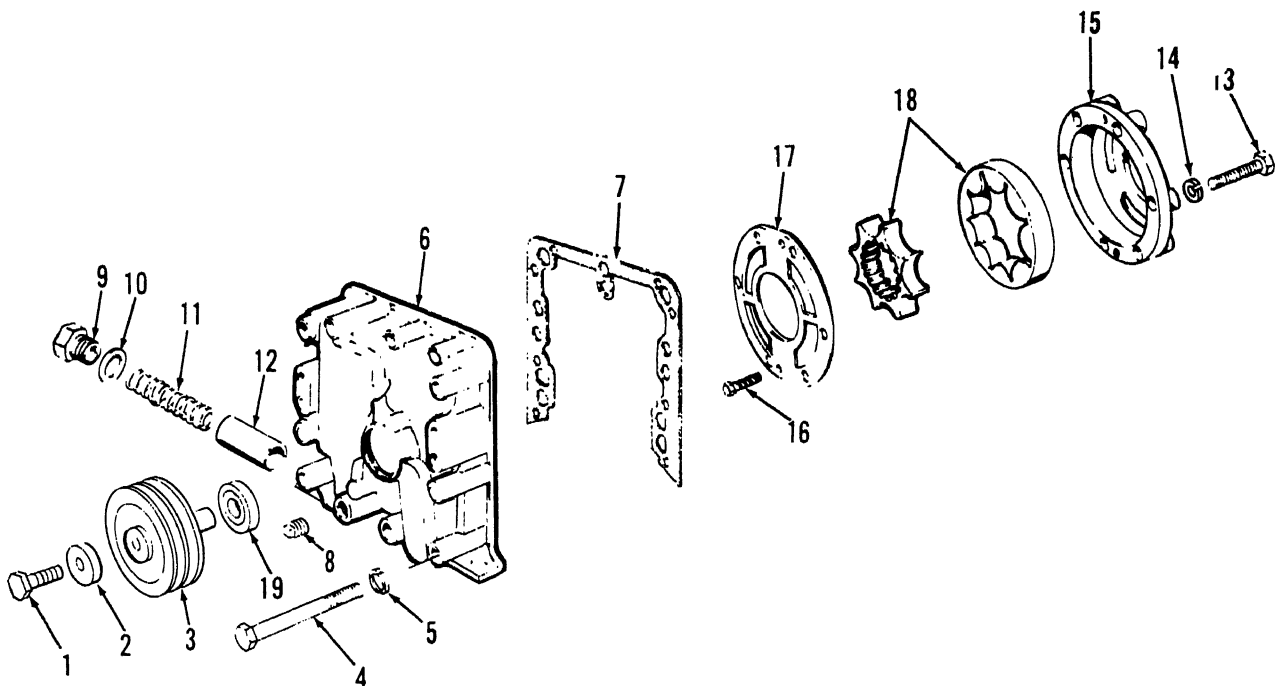
4-21. Removal

a. Refer to chapter 4, section VII and remove the

engine oil pan.

b. Refer to figure 4-13 and remove crankshaft bolt (1), pulley spacer (2). Using a suitable puller, remove crankshaft pulley (3).

c. Remove bolts (4) and lock washers (5). Separate and remove front cover (6) and gasket (7).



TA203514 ■

- 1 Bolt
- 2 Pulley retainer
- 3 Pulley
- 4 Bolt
- 5 Lock washer
- 6 Front cover
- 7 Gasket
- 8 Plug
- 9 Plug
- 10 Gasket

- 11 Spring
- 12 Regulator valve
- 13 Screw
- 14 Lock washer
- 15 Rotor cover
- 16 Screw
- 17 Oil pump cover
- 18 Rotor assembly
- 19 Crankshaft oil seal

Figure 4-13. Front cover and oil pump assembly—exploded view.

4-22. Disassembly

a. Refer to figure 4-13. Remove plug (8) from front cover (6).

b. Remove plug (9), gasket (10), spring (11) and regulator valve (12).

c. Remove screws (13), lock washers (14) and remove the oil pump assembly from the cover.

d. Remove screws (16) and separate cover (17) from rotor cover (15). Remove rotor assembly (18).

e. Support the front cover with two wood blocks next

to the oil seal bore. Press or drive seal (19) from the cover.

4-23. Cleaning, Inspection and Repair

a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent, before inspection.

b. Inspect oil pump rotor assembly for indications of excessive wear, cracks or pitting. Check rotor drive gear teeth for wear and cracks.

c. Inspect front cover for cracks and damage. Replace damaged cover. Inspect pulley and crankshaft bolt for wear.

d. Replace all seals and gaskets.

4-24. Reassembly

a. Refer to figure 4-13. Coat the bore of the cover housing with non-hardening sealant. Apply grease to the lip of oil seal (19). Position the seal in the cover with the seal lip pointing toward the inner face of the cover.

b. Place the cover in an arbor press. Press the seal into the bore until the seal is flush with the outside face of the cover. Remove all excess sealant.

c. Coat rotor assembly (18) parts with clean engine oil. Install the assembly in rotor cover (15). Place cover (17) into position on the rotor cover, and secure with screws (16).

d. Install the assembled rotor housing into front

cover (6) and secure with screws (13) and lock washers (14).

e. Install regulator valve (12), spring (11), new gasket (10) and plug (9). Install plug (8) in cover (6).

4-25. Installation

a. Refer to figure 4-13. Affix a new cover gasket (7) to the engine cylinder block.

b. Install two temporary guide studs in the cylinder block to guide the cover in place without damaging the crankshaft oil seal.

c. Apply a light coat of cup grease to the lip of the oil seal. Push the cover into place slowly, until the pump contacts the drive gear on the crankshaft. Rotate the crankshaft slightly to align the teeth, then push the cover up against the gasket and block.

d. Remove the pilot studs installed previously.

e. Install bolts (4) and lock washers (5). Tighten the bolts to 30—35 ft-lb (41—47 N • m).

f. Lubricate the end of the shaft and install pulley (3). Install pulley retainer (2) and secure with crankshaft bolt (1). Tighten the crankshaft bolt to 290—300 ft-lb (393—407 N • m).

g. Refer to chapter 4, section VII and install the engine oil pan.

Section VI. REPAIR OF CAMSHAFT AND BALANCE SHAFT

4-26. Description

The camshaft and balance shaft are located just below the top of the cylinder block. The camshaft is supported by end bearings and intermediate bearings pressed into the block. The balance shaft is supported by end bearings only. The shafts are driven from the crankshaft gear, through an idler gear. In turn, the camshaft and balance shaft gears drive the air blower and governor, in addition to providing the usual function of driving the exhaust valves and fuel injectors.

4-27. Removal

a. Refer to TM 5-3810-295-12 and remove the radiator, hoses, fan, fuel lines, and filters. Refer to paragraph 3-14 and remove radiator.

b. Refer to chapter 3 and remove engine accessories.

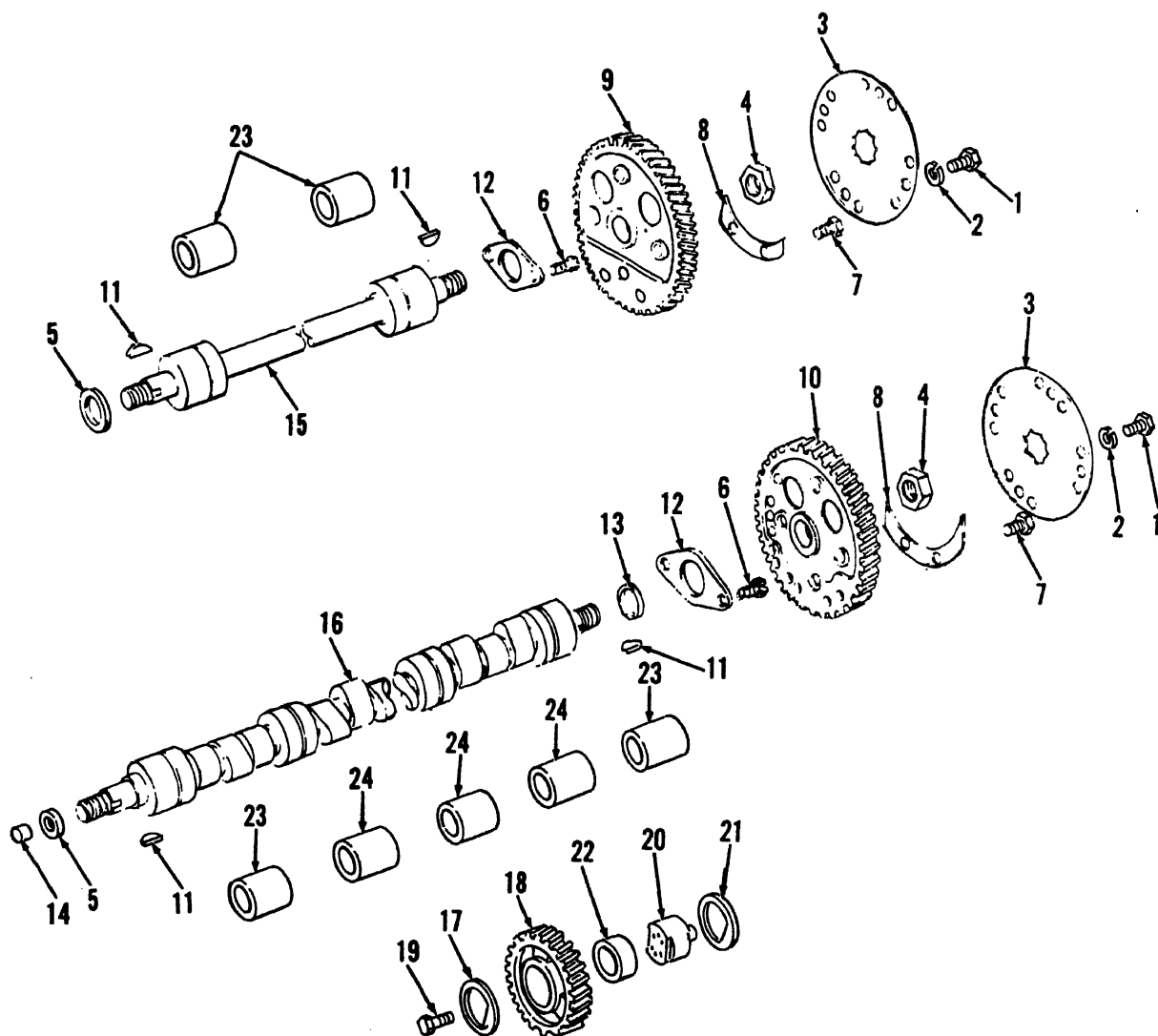
c. Refer to chapter 2 and remove the engine from the crane.

d. Refer to chapter 4 and remove cylinder head, upper front cover, flywheel, and flywheel housing.

4-28. Disassembly

a. Refer to figure 4-14. Remove retainer screws (1), lock washers (2) and gear nut retainer plates (3).

b. Wedge a clean rag between the camshaft gear and the balance shaft gear. Remove nut (4) from each shaft. (Balance weights, or pulleys, and shaft nuts should have been removed from the front end of the shafts previously as part of the upper front cover removal procedure.)



TA033187

- 1 Retainer screw
- 2 Lock washer
- 3 Gear nut retainer plate
- 4 Nut
- 5 Oil slinger
- 6 Screw
- 7 Screw
- 8 Balance weight
- 9 Balance shaft gear
- 10 Camshaft gear
- 11 Woodruff key
- 12 Thrust washer

- 13 Camshaft spacer
- 14 End plug
- 15 Balance shaft
- 16 Camshaft
- 17 Outer thrust washer
- 18 Idler gear
- 19 Bolt
- 20 Hub
- 21 Inner thrust washer
- 22 Idler gear bearing
- 23 End bearing
- 24 Intermediate bearing

Figure 4-14. Camshaft and balance shaft assembly—exploded view.

c. Remove oil slingers (5) from the front end of the shafts.

d. Remove thrust washer retaining screws (6) through a hole in the web of the gears.

e. Withdraw the shaft, thrust washer and gear as an assembly from the rear end of the cylinder block.

f. Remove balance weight retaining screws (7) from

the gears. Remove weights (8).

g. Place the camshaft and gear assembly in an arbor press. Lay a wood block beneath the camshaft so the threads will not be damaged when the shaft is pressed from the gear.

h. Place a short piece of $\frac{3}{4}$ -inch O.D. brass rod between the end of the camshaft and the ram of the press.

Force the camshaft out of gear (10).

i. Remove thrust washer (12), Woodruff key (11), and spacer (13) from camshaft (16). Remove gear (9) from balance shaft (15) in a similar manner.

j. Remove end plugs (14) from the shafts to permit cleaning of oil passages in the shafts. Drill and tap a $\frac{3}{8}$ -inch hole in the end plug and using a suitable puller, remove the end cap plug. Insert a $\frac{3}{8}$ -inch steel rod through the shaft and drive the plug from the opposite end of the shaft.

k. Remove idler gear outer thrust washer (17). Slide idler gear (18) from the idler hub.

l. Remove bolt (19) and remove idler hub (20) and inner thrust washer (21). Press bearing (22) from gear (18).

m. If necessary, bearings (23) and (24) may be pressed from the cylinder block.

NOTE

When removing bearings, be sure to note the position of the bearings in the bore with respect to the notch in the bearings. Replacement bearings must be installed in the same position.

4-29. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent before inspection.

b. Replace all seals and gaskets.

c. Replace shaft end plugs.

d. Be sure oil holes in the camshaft and balance shaft are clean.

e. Inspect shaft cams and journals. If they are badly scored or worn, replace the shaft.

f. Inspect both faces of the thrust washers. Replace the washers if they are worn or scored. Inspect the surfaces against which the thrust washers contact. If these surfaces are scratched, but not severely scored, smooth the surface with an oil stone.

g. Inspect shaft bearings for signs of excessive wear or scoring. Clearance between new shafts and bearings is from 0.0045 to 0.006 inch, or a maximum of 0.008 for worn parts.

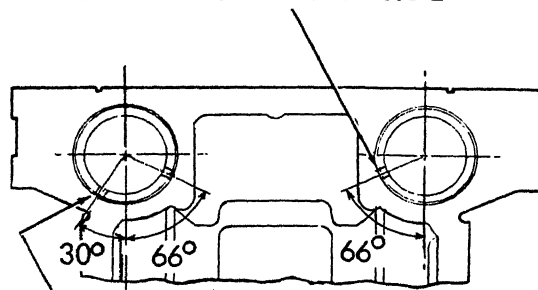
h. Inspect all gears for wear, cracks, and pitting. Replace gears with missing or broken teeth, or those showing signs of excessive wear.

4-30. Reassembly

a. Refer to figure 4-14. Install intermediate bearings (24) into the camshaft bores. Then install end bearings (23) in both the camshaft and balance shaft bores. Install bearings from front to rear in the cylinder block. Refer to figure 4-15 for correct location of lubrication grooves.

b. Place rear camshaft spacer (13) over the timing gear end of camshaft (16). Install Woodruff key (11).

NOTCH INBOARD AS SHOWN
ALL BEARINGS THIS SIDE



NOTCH OUTBOARD AS SHOWN
ALL BEARINGS THIS SIDE

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Figure 4-15. Camshaft and balance shaft bearing installation.

c. Lubricate thrust washer (12) with clean engine oil and place the thrust washer over the gear end of the camshaft and spacer.

d. Start camshaft gear (10) over the end of the camshaft with the key in shaft registering with the keyway in the gear.

e. With the camshaft supported in an arbor press, place a sleeve on top of the gear and under the ram of the press. Press the gear tight against the spacer on the shaft.

f. Measure the clearance between the camshaft thrust washer and the camshaft. This clearance should be between 0.008 and 0.015 inch with new parts. With used parts, a clearance of 0.021 inch is allowable.

g. Install weight (8) and secure with screws (7).

h. Install retaining nut (4) in the camshaft by hand.

i. Install the balance shaft gear on the balance shaft in the same manner.

j. Lubricate the camshaft and balance shaft with clean engine oil and slide the shafts into the cylinder block. Be careful not to damage the bearings, cams and journals.

NOTE

Make sure that the appropriate timing marks on the gears are aligned.

k. Slide oil slingers (5) on the front of the shafts.

l. Refer to chapter 4 and install upper front cover.

m. Install thrust washer screws (7) and tighten the screws to 30–35 ft-lb (41–47 N · m).

n. Refer to chapter 4 and install the front balance weights (pulleys).

o. Install gear nut retainer plates (3) and secure with screws (1) and lock washers (2). Tighten the screws to 35–39 ft-lb (47–53 N · m).

p. Check clearance between the thrust washer and gear on each shaft. Clearance should be between 0.008 to 0.015 inch, or a maximum of 0.019 inch with used parts. Check backlash between the mating gears.

q. Place inner thrust washer (21) on the forward end of the idler gear hub (20). Be sure the oil grooves in the thrust washer face the idler gear.

r. Press bearing (22) into the bore of gear (18).

s. Place the small protruding end of the idler gear hub (20) through the hole in the end plate and into the counterbore in the cylinder block.

t. Install two pilot bolts through the hub to align the assembly. Install bolt (19) and tighten the bolt to 40—45 ft-lb (54—61 N · m). Remove the two pilot screws.

u. Lubricate the idler hub and idler gear bearing with clean engine oil. Position the crankshaft gear and balance gear so their timing marks align with those on the idler gear. Install idler gear (18).

v. Apply a thin coat of cup grease to the inner face of outer thrust washer (17). Place the thrust washer over the end of the idler gear hub with the oil grooves facing the idler gear.

w. Check backlash between mating gears. Backlash should be 0.003 to 0.005 inch for new gears, and should not exceed 0.007 inch for used gears.

4-31. Installation

a. Refer to chapter 4 and install flywheel housing, flywheel, and cylinder head.

b. Refer to chapter 2 and install engine in the crane.

c. Refer to chapter 3 and install engine accessories.

d. Refer to TM 5-3810-295-12 and install fan, hoses, lines and filters. Refer to paragraph 3-18 and install the radiator. Time engine in accordance with instructions given in TM 5-3810-295-12.

Section VII. REPAIR OF OIL PAN

4-32. Description

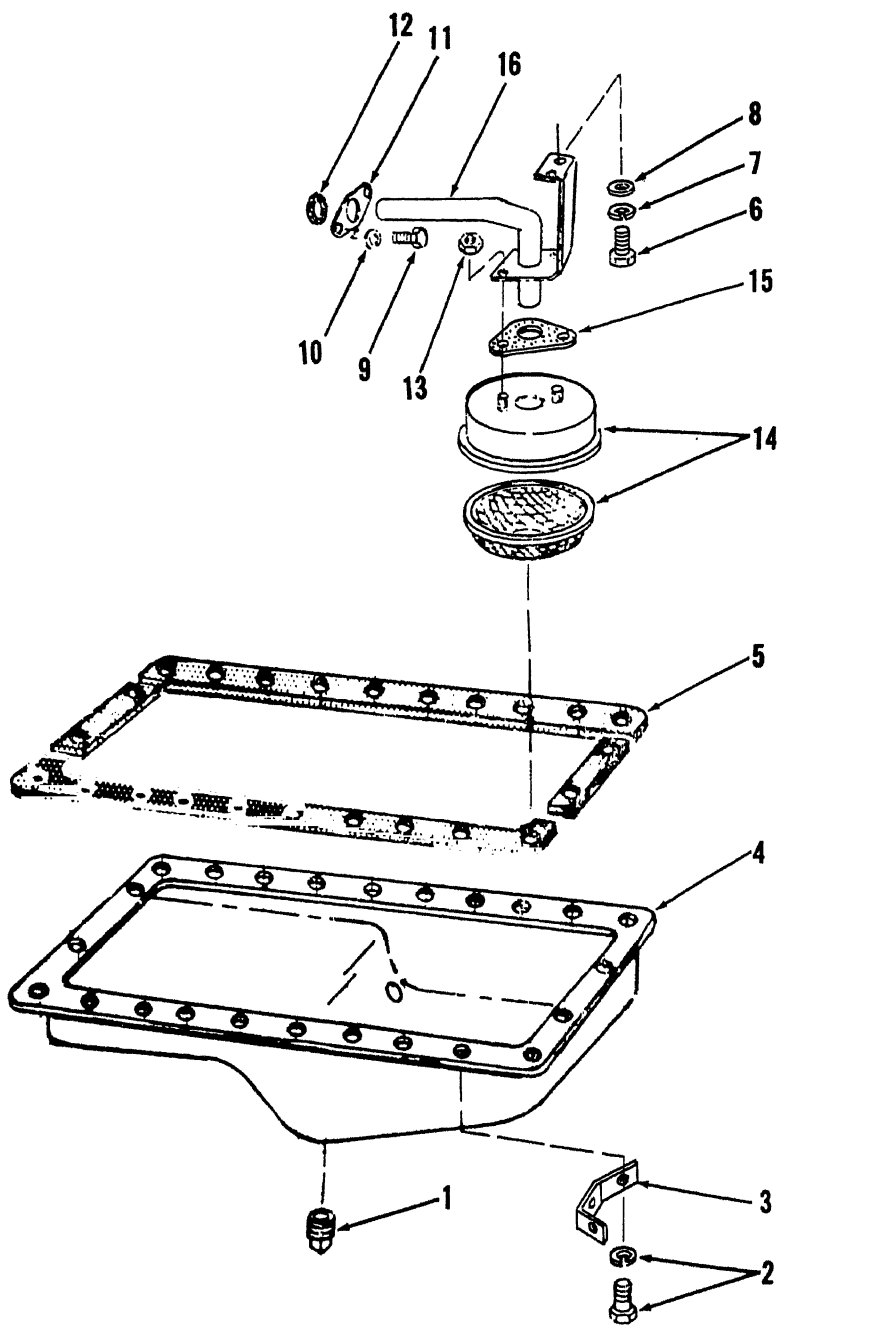
The oil pan is made of cast aluminum.

4-33. Removal and Disassembly

a. Refer to chapter 2 and remove the engine from

the crane.

b. Refer to figure 4-16. Remove plug (1) and drain lubricating oil from the engine.



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- | | |
|----------------|--------------------|
| 1 Plug | 9 Screw |
| 2 Screw/washer | 10 Lock washer |
| 3 Bracket | 11 Flange |
| 4 Oil pan | 12 Seal ring |
| 5 Gasket | 13 Nut |
| 6 Screw | 14 Screen assembly |
| 7 Lock washer | 15 Gasket |
| 8 Flat washer | 16 Pipe |

Figure 4-16. Oil pan and oil inlet screen assembly—exploded view.

c. Remove screw/washers (2) and bracket (3). Lower oil pan (4) from the engine. Be careful to avoid damaging the oil inlet screen and pipe.

d. Remove gaskets (5).

e. Remove screw (6), lock washer (7) and flat washer (8). Remove screws (9) and washers (10) and withdraw the oil screen and pipe assembly from the engine.

f. Remove flange (11) and seal ring (12).

g. Remove nuts (13) and separate screen assembly (14) from pipe (16). Remove gasket (15).

4-34. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent before inspection.

b. Replace all gaskets and seals.

c. Inspect the pan for porosity and cracks. Check for misaligned flanges and raised surfaces surrounding the bolt holes.

4-35. Reassembly and Installation

a. Refer to figure 4-16. Install a new gasket (15) on screen assembly (14) and install the assembly on pipe (16). Secure with nuts (13).

b. Install flange (11) and seal ring (12) on the pipe assembly. Install the pipe and screen assembly in the crankcase and secure with screws (9) and (6), lock washers (10) and (7), and flat washers (8).

c. Install a new gasket (5) and position oil pan (4) on the crankcase. Secure with screws (2) and install bracket (3). Tighten the screws uniformly to prevent damaging the gasket or springing the pan. Install plug (1).

d. Replenish the lubricating oil supply per LO 5-3810-295-12-1, -2 & -3.

e. Refer to chapter 2 and install the engine in the crane.

Section VIII. REPAIR OF CRANKSHAFT, PISTONS AND RODS

4-36. Description

The crankshaft supports the connecting rod and pistons along its length. At the rear end is the crankshaft gear which drives the camshaft and associated accessories. The connecting rods serve as the links between the crankshaft and the pistons.

4-37. Removal and Disassembly

a. Refer to chapter 2 and remove engine from the crane.

b. Drain cooling system and drain engine crankcase.

c. Refer to chapter 4 and remove oil pan, oil inlet pipe and screen, flywheel and flywheel housing, lower front cover, and cylinder head.

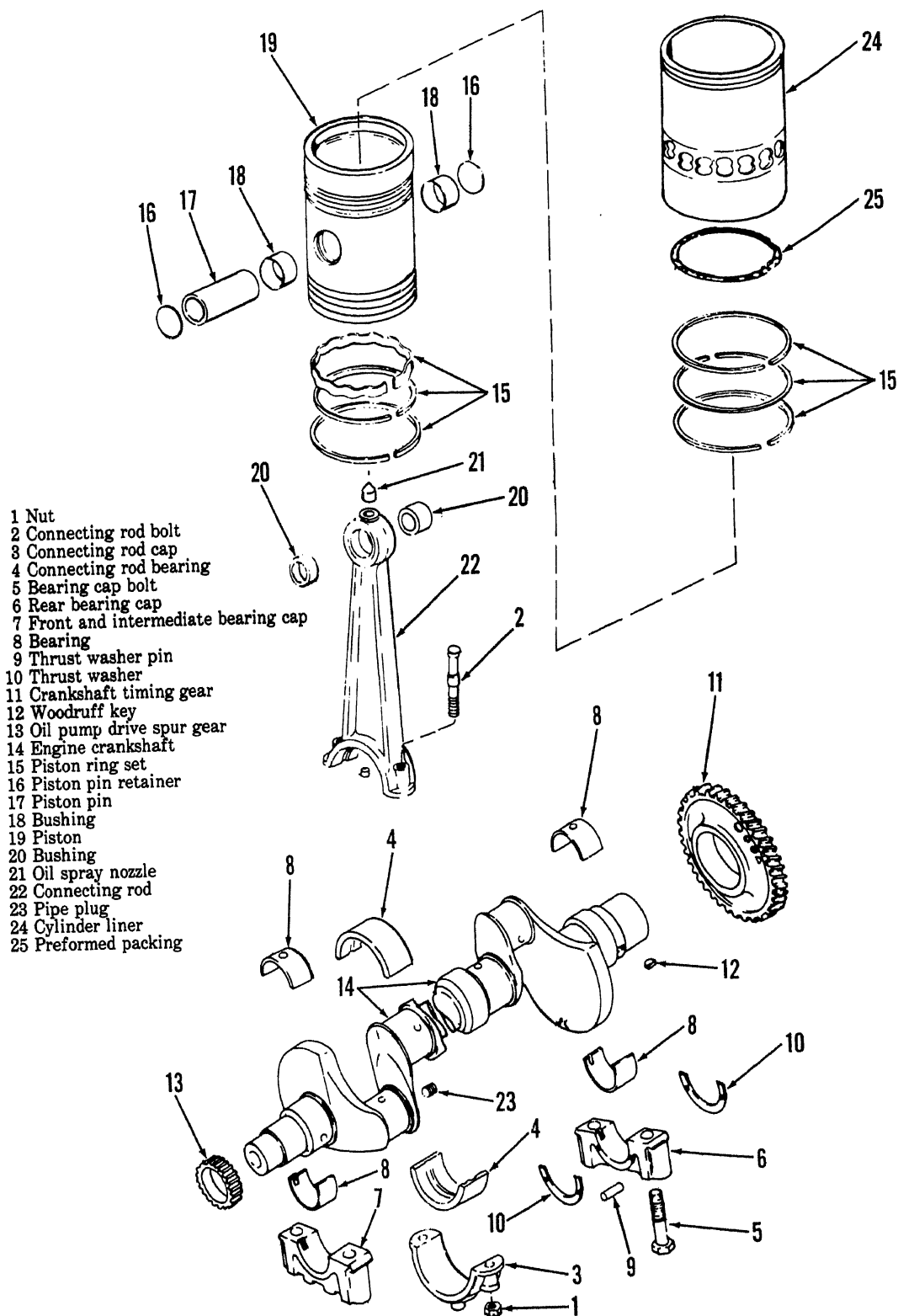
d. Refer to figure 4-16A. Remove nuts (1), rod bolts (2), rod caps (3) and bearings (4).

e. Remove carbon from the upper inner surface of the cylinder liner and lift connecting rod and piston assemblies from the top of the block.

f. Remove bearing cap bolts (5). Lift off bearing caps (6) and (7), and bearings (8). Remove thrust washer pin (9) and thrust washers (10) from each side of the rear main bearing.

g. Using a suitable lifting device, remove crankshaft (14) from the crankcase.

h. Use a suitable puller and remove crankshaft timing gear (11) from the crankshaft. Remove Woodruff key (12) from the shaft.



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Figure 4-16A. Crankshaft, connecting rod, and piston assembly—exploded view.

i. Remove oil pump drive spur gear (13) from the front end of the crankshaft.

j. Using a suitable expander wrench, remove both piston ring sets (15).

k. Punch a hole through the center of one piston pin retainer (16) and remove the retainer. Withdraw piston pin (17) from the piston and remove the connecting rod assembly from the piston. Drive the other retainer from the piston.

l. Drive bushings (18) from piston (19).

m. Drive bushings (20) from the connecting rod (22). Using an arbor press, remove the spray nozzle (21) from the connecting rod.

n. Place a hardwood block against the lower end of cylinder liner (24). Gently tap the hardwood block until the liner is free. Remove liner (24) and packing (25).

CAUTION

Do not attempt to loosen the cylinder liner by inserting a long bolt or rod through the port openings in the liner.

4-38. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent, before inspection.

b. Replace all seals, gaskets, piston pin retainers, and piston rings. Replace oil pump drive spur gear.

c. Carefully inspect the crankshaft for cracks which start at the oil holes and follow the journal surface at an angle of 45° to the axis. Crankshafts with such cracks should be replaced. The following method may be used to detect such cracks that may not be visible to the eye. Magnetize the crankshaft and then cover it with a fine magnetic powder. Powder will collect at crack lines. Demagnetize the crankshaft before installing it in the engine. Other methods used for inspecting crankshafts are fluorescent magnetic particle inspection, and fluorescent penetrant inspection.

d. Inspect keyways for evidence of cracks or wear. Check for ridging on the upper main bearing shell or lowering connecting rod bearing shell. Ridges exceeding 0.0002 inch must be removed.

e. Remove ridges with crocus cloth. If ridges are greater than 0.0005 inch, use 120 grit emery cloth to clean up the ridge, 240 grit emery cloth to finish the ridge, and crocus cloth for polishing. If ridges are greater than 0.001 inch, the crankshaft may need to be replaced.

f. Carefully inspect the front and rear end of the crankshaft around the oil seal surface area for evidence of rough or grooved condition. Use emery cloth and crocus cloth to clean up any ridges in this area.

g. Check the crankshaft thrust surfaces for excessive wear or grooving. Slight imperfections may be dressed with a stone. Otherwise, the surface should be reground.

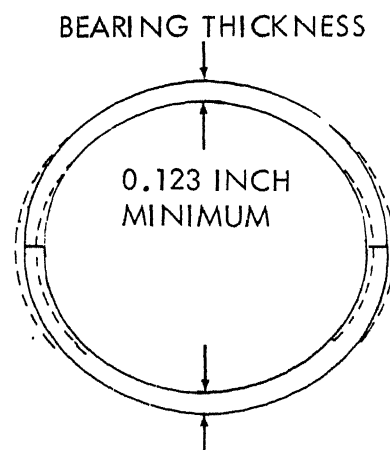
h. Check the oil pump drive gear and the crankshaft timing gear for worn or chipped teeth, and cracks near the root of the teeth. If badly worn, replace the gears.

i. Support the crankshaft on its front and rear journals on V-blocks or a lathe. Check alignment at the adjacent intermediate main journals with a dial indicator. Maximum runout on the intermediate journals must not exceed 0.002-inch total indicator reading.

j. Measure all main and connecting rod bearing journals. Measure the journals at several places on the circumference so that taper, out-of-round and bearing clearances can be determined. Maximum connection rod journal-to-bearing clearance should not exceed 0.0045 inch. Main bearing journal-to-bearing shell clearance should not exceed 0.0040 inch. Journal taper or out-of-round should not exceed 0.003 inch. If any of these out-of-tolerance conditions exist, the crankshaft should be replaced.

k. Inspect bearings for scoring, pitting, etching, flaking and dirt grooving. Replace defective bearings. Inspect the backs of the bearing shells for bright spots. These indicate movement within the cap. Replace such bearing shells.

l. Measure the thickness of the bearing shells as shown in figure 4-17. Minimum thickness of a used bearing shell is 0.123 inch. Replace any shells thinner than this. Do not replace one main bearing shell by itself. If one shell needs replacement, install both new upper and lower shells.



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Figure 4-17. Main bearing shell measurements.

m. Inspect piston for signs of excessive wear, scoring, or wearing away of the tin coating. Check for cracks across the struts inside the piston. Check piston grooves. Replace badly worn pistons.

n. Inspect and measure the piston pin and piston pin bushings. The piston-to-bushing clearance with new

parts is 0.0025 to 0.0034 inch. Maximum clearance for used parts is 0.010 inch.

o. Blow dry air through the oil passage in the connecting rod and spray nozzle to be sure the holes are open. Check the connecting rod for cracks using a magnaflux procedure. Inspect connecting rod bushings for signs of wear, scoring, overheating or other damage.

p. Check clearance between the piston pin and the connecting rod bushings. If clearance exceeds 0.010 inch with used parts, replace the piston pin and/or bushings.

q. Inspect cylinder liners for scoring, pitting, heat fatigue, and wear. Replace any liners that are badly worn or scored.

4-39. Reassembly and Installation

a. Refer to figure 4-16A. Press a new oil pump drive spur gear (13) onto shaft (14). Check the press fit of the gear on the shaft. The gear should not slip on the crankshaft at 100 foot-pounds (136 N·m).

CAUTION

Do not exceed this torque. If the gear slips on the shaft, replace the gear.

b. Install Woodruff key (12) and install crankshaft timing gear (11) on the crankshaft.

c. Install upper bearing shells (8) in the same locations from which they were removed. The upper shells are grooved.

d. Apply clean engine oil to all crankshaft journals and install the crankshaft in place so that the timing marks on the crankshaft timing gear and the idler gear

match. Check timing gear backlash. The specified backlash with new gears is 0.003 to 0.005 inch, and a maximum of 0.008 inch for used parts.

e. Install the upper half of the crankshaft thrust washers (10) on each side of the rear main bearing support. Install the lower half of the thrust washers on each side of the rear main bearing cap (6). Install thrust washer pins (9).

NOTE

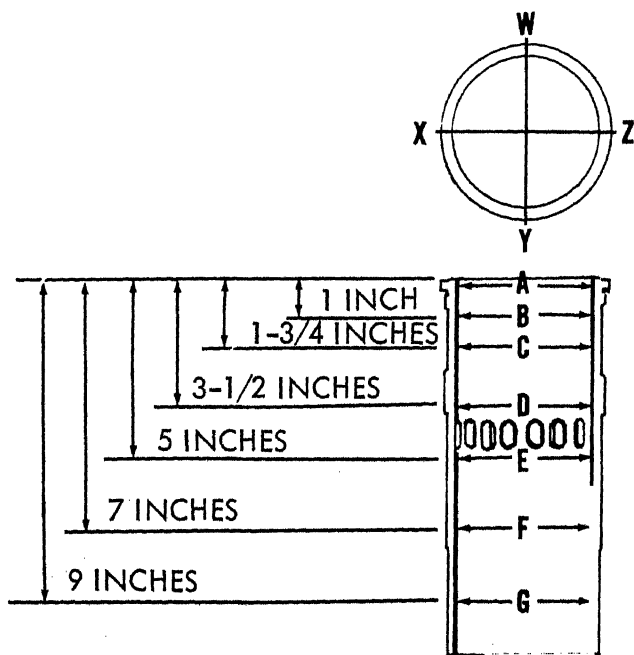
The grooved side of thrust washers must face the crankshaft thrust surfaces.

f. Install lower bearing shells (8) in bearing caps (7) and (6), in the same positions from which they were removed. Install bearing cap bolts (5) and bearing caps (6) and (7). Draw the bolts up snug. Rap each cap sharply with a soft hammer to seat them properly.

g. Draw the bearing cap bolts uniformly tight, starting with the center cap and working alternately toward both ends of the block. Tighten the bolts to 120–130 ft-lb (163–176 N·m). The crankshaft should turn freely.

h. Check crankshaft end play with a dial indicator. End play should be between 0.004 and 0.011 inch with new parts, or a maximum of 0.018 inch with used parts.

i. Install cylinder liners (24) in the cylinder block. Then measure the liner as shown in figure 4-18. If the taper exceeds 0.002 inch, or the out-of-round exceeds 0.003 inch, replace the cylinder liner. Tap the liner lightly with a soft hammer to assure it is properly seated against the bottom of the counterbore.



NOTE: MEASURE INSIDE DIAMETER OF LINER AT PLACES A, B, C, D, E, F, AND G ON "XZ" AND "WY" AXIS.

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Figure 4-18. Cylinder liner measurements.

j. Clamp the liner in place with a hold-down clamp, and measure the distance from the top of the liner flange to the top of the block with a dial indicator. The top of the flange should be 0.0465 to 0.050 inch below the top of the block. There should not be more than 0.0015 inch difference between any two adjacent liners when measured along the cylinder longitudinal center line. If the above limits are not met, install the liner in another bore and recheck, or replace the liner.

k. Matchmark the liner and the block with chalk or paint so the liner may be reinstalled in the same position in the same bore. Place the matchmark on the engine serial number side of the block. Remove hold-down clamps.

l. Install bushings (18) in piston (19), and ream the bushings. The inside diameter of the bushings must be 1.3775 to 1.3780 inches. Insert the cylinder into the liner and measure the piston-to-liner clearance with a feeler gauge, at four places around the circumference of the piston. Clearance should be 0.0031 to 0.0068 for new parts, or a maximum of 0.010 inch for used parts. Mark the piston and remove it from the liner.

m. Insert one piston ring at a time far enough down the cylinder liner to be within the normal operating area of the ring. Use a piston to push the ring down to be sure it is parallel with the top of the liner. Measure the ring gap with a feeler gauge. Gap should be 0.020—0.046 inch for chrome rings and 0.020—0.036 inch for cast iron rings.

n. Press spray nozzle (21) into the top of the connecting rod (22) until it bottoms in the counterbore. Install bushings (20) into the connecting rod, with the joint located at the top of the connecting rod. Ream connecting rod bushings to 1.3760 to 1.3765 inches.

o. Lubricate piston pin (17) and bushings (18) and (20) and assemble the piston and connecting rod. Install new pin retainers (16). Place the piston and connecting rod upside down on the work bench. Fill the inside of the piston with clean fuel oil to a level above the piston bosses. Dry the outside of the piston and allow it to set for approximately fifteen minutes. If fuel oil leaks around the retainers, install new retainers.

p. Install piston rings (15) on pistons (19). Apply clean engine oil to the piston, rings, and the inside of an appropriate ring compressor. Position the piston

ring gaps in a staggered array and start the top of the piston straight into the ring compressor.

q. Remove individual cylinder liners and place the piston and rod assembly on the liner with the numbers on the rod and cap aligned with the matchmark on the liner.

NOTE

The numbers on the side of the connecting rods and caps identify the rod with the cap and indicate the cylinder in which they are to be used. If a new connecting rod is to be installed, the same identification number must be stamped on the new connecting rod.

r. Push the piston and rod assembly into the liner until the piston is out of the ring compressor. Remove the rod cap and ring compressor. Push the piston into the liner until the compression rings pass the liner ports.

s. Install seal ring (25) into the cylinder block. Apply hydrogenated vegetable oil or a permanent anti-freeze solution to the inner surface of the seal ring. Rotate the crankshaft until the connecting rod journal of the cylinder being worked on is at the bottom of its travel. Lubricate the journal with clean engine oil.

t. Install the upper bearing shell (4) (the one with a short groove at each parting line), in the connecting rod. Lubricate the shell with clean engine oil.

u. Install the assembled piston, connecting rod, and liner into the top of the block so that the identification number on the rod faces the serial number side of the engine. Also, align the match marks on the liner with those on the block. Insert the assembly until the connecting rod mates with the crankshaft journal.

v. Place the lower bearing shell (4) in the connecting rod cap (3). Lubricate the bearing shell with clean engine oil. Install bearing cap (3) and secure with rod bolts (2) and nuts (1). Tighten the nuts to 40 to 45 ft-lb (54—61 N·m).

w. Check the connecting rod side clearance. Clearance should be 0.006 to 0.012 with new parts.

x. Refer to chapter 4 and install the cylinder head, lower front cover, flywheel and flywheel housing, oil inlet pipe and screen, and oil pan. Replenish coolant and lubrication oil. Refer to chapter 2 and install the engine in the crane.

Section IX. REPAIR OF CYLINDER BLOCK

4-40. Description

The cast iron cylinder block is a one-piece casting which forms the main structural part of the engine. Transverse webs provide rigidity and strength and assure alignment of the block bores and bearings under load.

4-41. Removal and Disassembly

a. Refer to chapter 2 and remove the engine from the crane.

b. Refer to chapter 3 and remove engine accessories and associated assemblies from the engine.

c. Refer to figure 4-19 and remove bolts (1), lock

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washers (2), access cover plate (3) and gasket (4).

d. Remove screws (5), lockwashers (6), air box cover (7) and gasket (8).

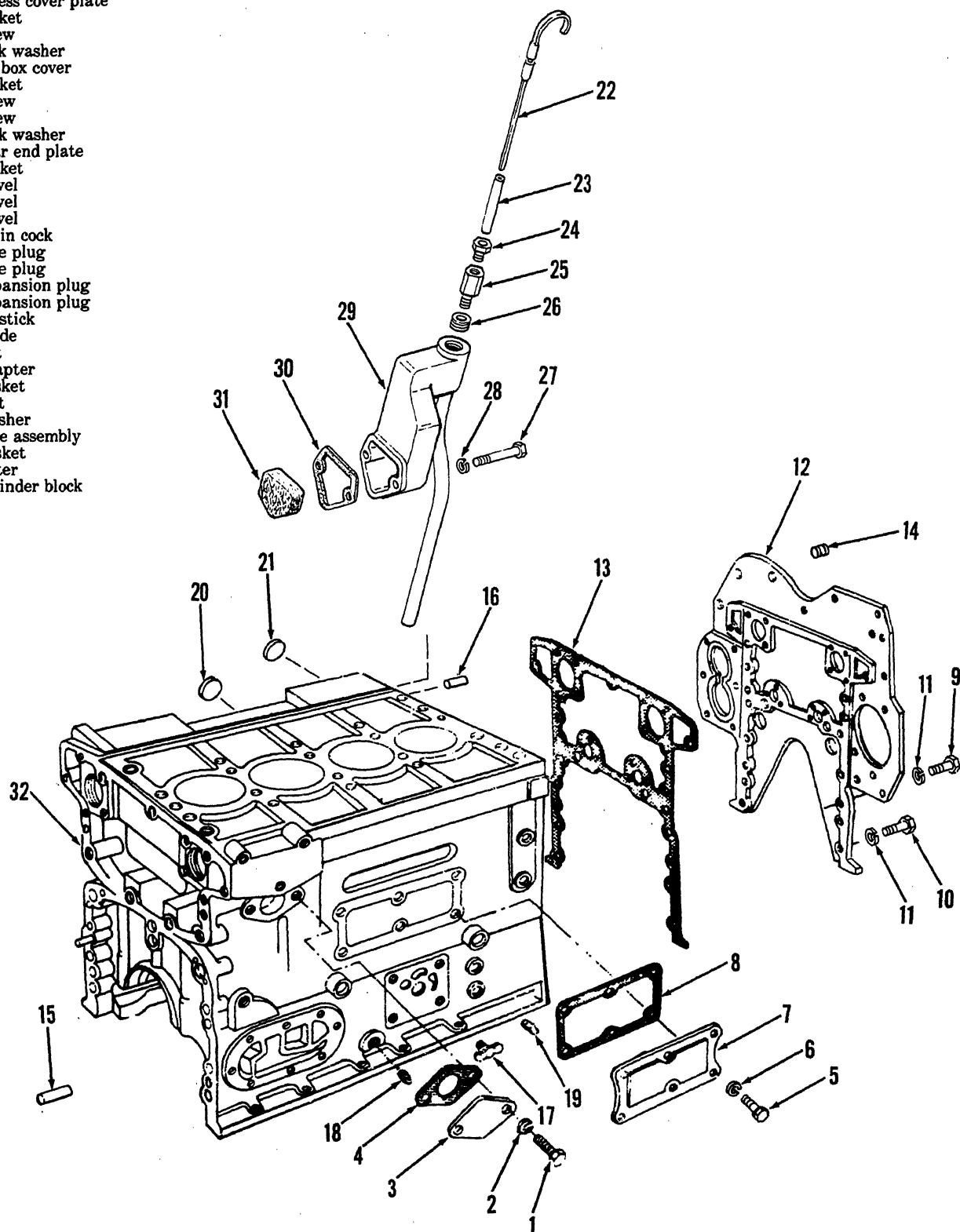
e. Remove screws (9) and (10) and lock washers (11), and separate rear end plate (12) from the cylinder block. Remove gasket (13) and dowel (14).

f. Remove dowels (15) and (16). Remove drain cock

(17) and pipe plugs (18) and (19) from cylinder block (32).

g. Remove dipstick (22), guide (23), nut (24), adapter (25), and gasket (26). Remove bolts (27), washers (28) and pipe assembly (29). Remove gasket (30) and filter (31).

- 1 Bolt
- 2 Lock washer
- 3 Access cover plate
- 4 Gasket
- 5 Screw
- 6 Lock washer
- 7 Air box cover
- 8 Gasket
- 9 Screw
- 10 Screw
- 11 Lock washer
- 12 Rear end plate
- 13 Gasket
- 14 Dowel
- 15 Dowel
- 16 Dowel
- 17 Drain cock
- 18 Pipe plug
- 19 Pipe plug
- 20 Expansion plug
- 21 Expansion plug
- 22 Dipstick
- 23 Guide
- 24 Nut
- 25 Adapter
- 26 Gasket
- 27 Bolt
- 28 Washer
- 29 Pipe assembly
- 30 Gasket
- 31 Filter
- 32 Cylinder block



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Figure 4-19. Cylinder block assembly—exploded view.

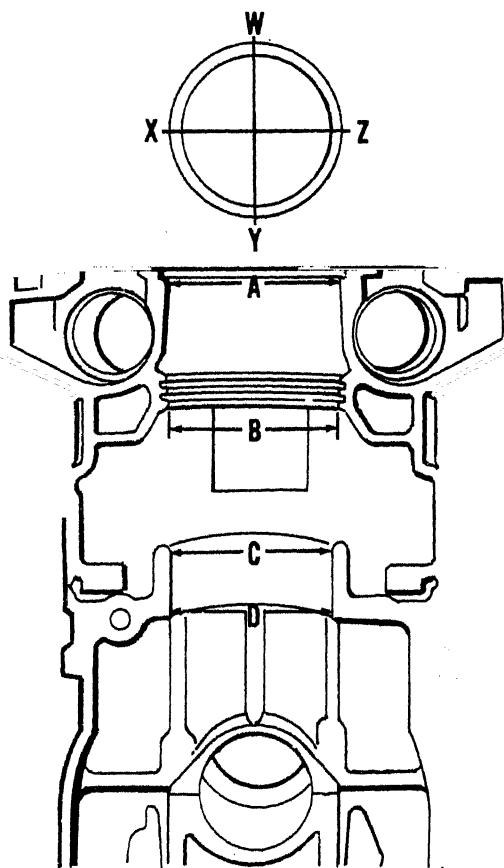
4-42. Cleaning, Inspection and Repair

- a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent, before inspection.
- b. Replace all gaskets and filters.
- c. Clean the block with live steam. Be sure the oil galleries, air box floor, and air box drain openings are thoroughly cleaned.
- d. Pressure test the block with 80 to 100 psi air pressure while the block is submerged in water heated to 180° to 200°F. Be sure all block openings have been sealed before proceeding with the test.
- e. Check the top of the block for flatness and warpage with an accurate straight edge and a feeler gage. The top surface must not vary more than 0.003 inch in

the transverse direction and not more than 0.007 inch in the longitudinal direction.

f. Inspect the seal ring grooves and lands for pitting and erosion. Two grooves are provided above the air inlet ports of each cylinder bore. Normally, the upper groove is used for the seal ring. If this groove or adjacent lands are badly pitted or eroded, the lower groove may be used. If both grooves are eroded to the extent that they affect sealing, the block should be replaced.

g. Measure each cylinder bore in accordance with figure 4-20, using a dial indicator calibrated in 0.0001 inch increments. Replace the block if tolerances cannot be maintained.



MAXIMUM ALLOWABLE MEASUREMENT

- A. 4.5235 INCH
- B. 4.4900 INCH
- C. 4.3595 INCH
- D. 4.3595 INCH

TAPER AND OUT-OF-ROUND
NOT TO EXCEED 0.0015 INCH.

NOTE: MEASURE INSIDE DIAMETER OF BLOCK BORE AT PLACES A, B, C AND D ON "XZ" AND "WY" AXIS.

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Figure 4-20. Block bore measurement diagram.

h. Install bearing caps and measure the main bearing bores. The main bearing bores must be within 3.251 to 3.252 inches. If the bores are not within these limits, replace the block.

i. Check all machined surfaces for nicks and burrs. Clean up nicks and burrs with a file. Check threaded holes in the block. Clean up damaged threads with a tap.

4-43. Reassembly and Installation

a. Refer to figure 4-19. Install pipe plugs (18) and (19), and drain cock (17). Install dowels (15) and (16) in the cylinder block.

b. Install a new filter (31), gasket (30), and pipe assembly (29). Secure with bolts (27) and washers (28).

Install gasket (26), adapter (25), nut (24), and guide (23). Install dipstick (22).

c. Affix a new gasket (13) and install end plate (12) at the rear of the block. Secure with screws (9) and (10) and lock washers (11). Install dowel pin (14) in the rear end plate.

d. Install new gasket (8) and air box cover (7). Secure with screws (5) and lockwashers (6).

e. Install new gasket (4) and access cover plate (3). Secure with bolts (1) and lock washers (2).

f. Refer to chapter 3 and install engine accessories and associated assemblies.

g. Refer to chapter 2 and install the engine in the crane.

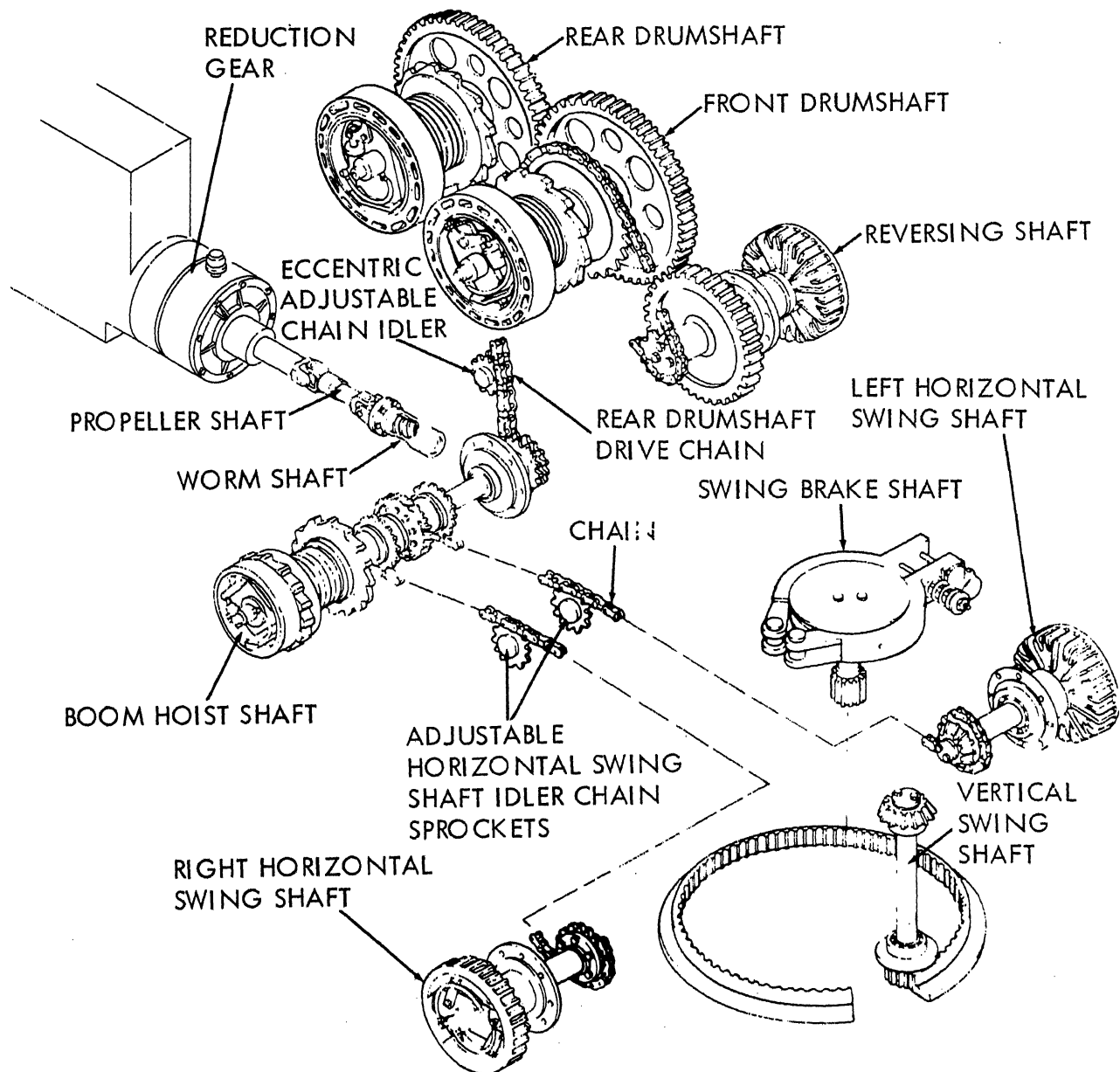
CHAPTER 5 REPAIR OF CRANE DRIVE AND TRAIN

Section I. REPAIR OF CRANE REDUCTION GEAR

5-1. Description

As is shown in figure 5-1, the crane reduction gear transfers mechanical power from the crane engine to the drive train components via the propeller shaft, worm gear and boom hoist shaft. The gear itself con-

sists of a complete clutch power take-off and reduction gear assembled into a single unit. The clutch is an over-center type, operating through a 3:1 reduction arrangement. The output shaft rotates in the direction of the engine rotation.



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Figure 5-1. Inter-relationship of crane drive train major components.

5-2. Removal

a. Refer to figure 5-2 and remove screw (1), lock washers (2), nuts (3) and clutch lever (4).

b. Refer to paragraph 2-11 and remove the reduction gear assembly from the engine. Place the assembly in a suitable stand for disassembly.

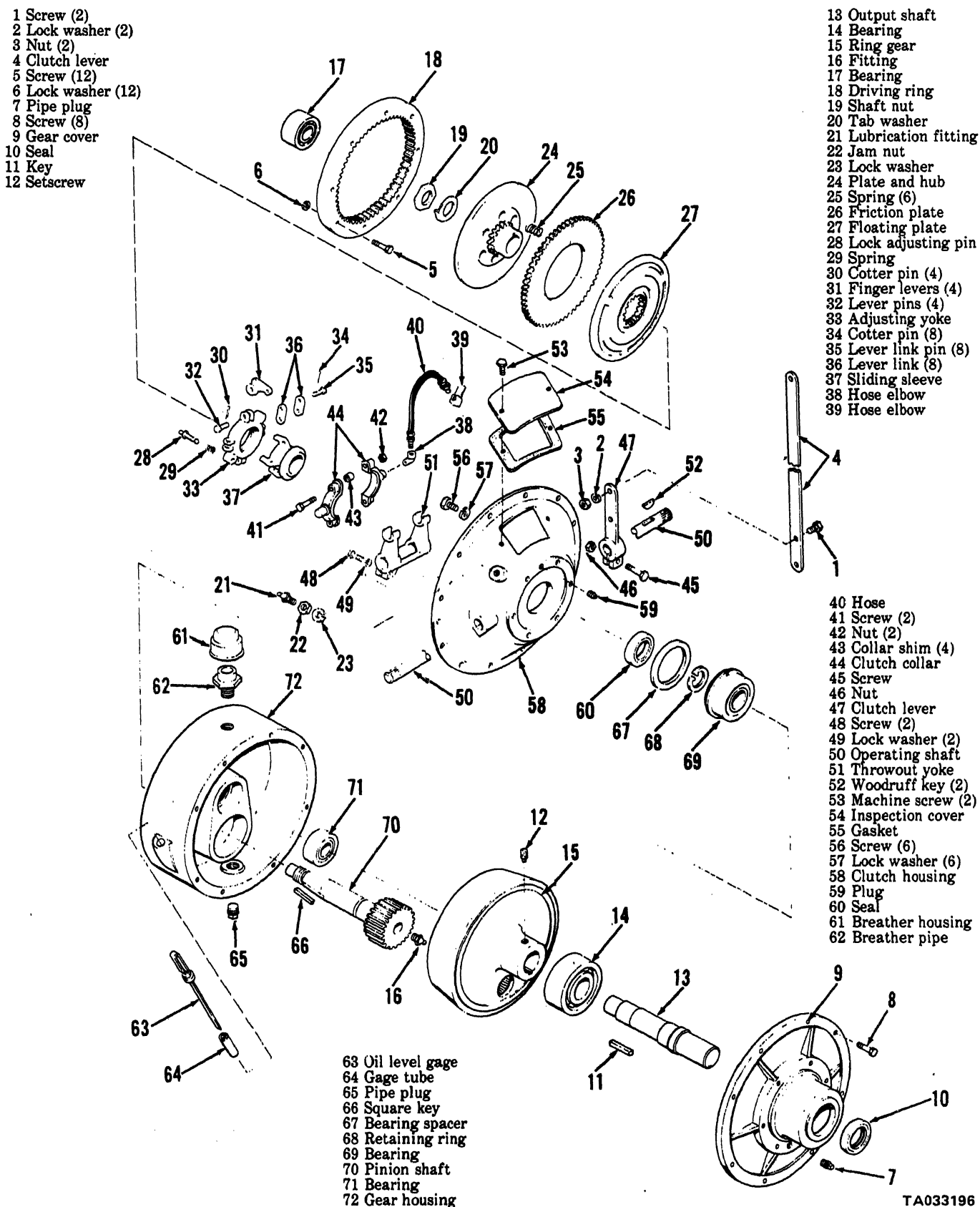


Figure 5-2. Reduction gear assembly—exploded view.

5-3. Disassembly

- a. Refer to figure 5-2 and remove screws (5) and lock washers (6) from driving ring (18).
- b. Remove pipe plug (7) from the gear cover on the output end, and remove screws (8). Lift off gear cover (9). Seal (10) will come off with the gear cover. Remove seal (10).
- c. Remove setscrew (12), and slide output shaft (13) from the ring gear. Bearing (14) will come off with the output shaft along with ring gear (15). Press bearing (14) from shaft (13). Remove fitting (16) from shaft (70).
- d. Remove pilot bearing (17) from shaft (70) using a standard puller, and remove driving ring (18).
- e. Remove shaft nut (19) and tabbed washer (20). Discard washer (20).
- f. Remove lubrication fitting (21), jam nut (22) and lock washer (23) from clutch housing, and push the end of hose (40) into the housing.
- g. Pull plate and hub (24), springs (25), friction plate (26) and floating plate (27) from shaft (70), using a gear puller fitted so the jack screw bears on the end of the shaft and grips around floating plate (27).

NOTE

Fit the pilot bearing end of the clutch shaft with a protective cap of steel, brass or bronze to prevent damage to the shaft end.

- h. Items (28) through (44) will come off with the floating plate. Remove hub key (66) at this time.
- i. Pull lock adjusting pin (28) out, and lock the assembly in the "out" position by inserting a piece of wire or small nail in the cross-drilled hole of the pin. Rotate the adjusting yoke assembly (items 29 through 37) and the sliding sleeve assembly (items 38 through 44) in a counterclockwise direction until they are removed from the threaded hub of hub and plate (24).
- j. Remove hub and plate (24), springs (25), friction plate (26) and floating plate (27).
- k. Remove adjusting pin (28) and spring (29). Remove cotter pins (30), finger levers (31), lever pins (32), and adjusting yoke (33). Remove cotter pins (34), lever link pins (35), lever links (36) and sliding sleeve (37).
- l. Remove hose elbows (38) and (39) and hose (40). Remove screws (41), nuts (42), collar shims (43) and clutch collar (44).

m. Remove screw (45), nut (46) and clutch lever (47). Remove screws (48), and lock washers (49). Slide operating shaft (50) from the clutch housing. Throwout yoke (51) will be removed when the operating shaft is removed. Remove keys (52) from the shaft.

n. Remove machine screws (53), inspection cover (54) and gasket (55).

o. Remove screws (56) and lock washers (57), and separate clutch housing (58) from gear housing (72). Remove plug (59).

p. Remove seal (60) from the clutch housing bore, and remove breather housing (61) and breather pipe (62) from gear housing (72). Oil level gage (63), gage tube (64) and pipe plug (65) can now be removed from the gear housing.

q. Remove bearing spacer (67), retaining ring (68) and press clutch shaft (70) and bearing (69) from gear housing (72). Remove bearing (69) from shaft (70). Bearing (71) can now be pressed from gear housing (72).

5-4. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent, before inspecting.

b. Replace all gaskets, cotter pins, tab washers, or deformed shims.

c. Inspect clutch driving plate for signs of excessive wear. If a rivet is within one-sixteenth of an inch of the surface of the asbestos lining surface, the lining or plate should be replaced.

d. Inspect all threaded items and replace any item with damaged or elongated thread.

e. Inspect all parts for wear, scoring, cracks, or other signs of damage or excessive wear, especially at the roots of the gear teeth.

NOTE

Lubricate all seal lips with oil or grease before reassembly.

5-5. Reassembly

a. Refer to figure 5-2 and install driving ring (18) and secure it with screws (5) and nuts (6).

b. Install operating shaft (50) approximately half way into clutch housing (58). Slip the throwout yoke (51) onto the operating shaft and push the shaft through the opening on the other side of the clutch housing. Install one of the Woodruff keys (52) into the operating shaft. Move the throwout yoke slightly on the shaft and install the other key. Secure the throwout yoke with screws (48) and lock washers (49). Tighten the screws to 38 to 42 ft-lb (52—57 N • m).

c. Install clutch lever (47) and secure it with screw (45) and nut (46), tighten to 86 to 95 ft-lb (117—129 N • m).

d. Apply Loctite plastic gasket between clutch housing (58) and gear housing (72), and between the gear housing and gear cover (9).

NOTE

Plastic gasket must cure for 12 to 24 hours at 72°F., or 20 to 30 minutes at 200°F.

e. Place gear housing (72) on wooden blocking on a work bench, clutch side up, and press bearing (69) into gear housing bore. Insert shaft (70) into bearing (69) and secure with retaining ring (68). Install bearing spacer (67) into recessed hub of the gear housing.

f. Install plug (59) in clutch housing (58) and mount

the gear housing on the clutch housing (58) and secure the assembly with screws (56) and lock washers (57). Install seal (60) into clutch housing bore.

g. Connect grease fitting (21) with hose elbows (38) and (39) and hose (40). Secure elbow (38) to clutch collar (44).

h. Place the split collar (44) and shims (43) on sleeve (37) and secure with screws (41) and nuts (42). Tighten nuts to 38—42 ft-lb (52—57 N · m).

i. Secure the eight lever links (36) to sliding sleeve (37) and secure with lever link pins (35) and cotter pins (34). Secure the four finger levers (31) to adjusting yoke (33) with lever pins (32) and cotter pins (30).

NOTE

To prevent interference with adjacent parts, the cotter pins must not extend beyond 0.38-inch radius of the pin center after spreading.

j. Install lock spring (29) and adjusting lock pin (28) in adjusting yoke (33).

k. Place hub and plate (24) on a work bench with the threaded hub up. Place the release springs (25), friction plate (26) and floating plate (27) in position on the hub and plate assembly.

l. Install adjusting yoke (33) with the assembled sliding sleeve (37) on the hub and plate assembly. Tighten the yoke until it is snug against the floating plate. Final clutch adjustment will be made later.

m. Partially install the clutch hub assembly onto shaft (70). Align the hub and shaft keyways and install key (66) into shaft and hub about two-thirds of the key length. Lower the clutch assembly further, engaging the throwout yoke with trunnions on the collar. Tap key (66) into final position.

n. Secure the clutch assembly to the clutch shaft by installing a new hub locknut washer (20) and hub nut (19). Seat the hub, using 30 ft-lb (41 N · m) torque on nut (19). Then tighten the nut by turning an additional 60° to 90° rotation. Bend a section of the tabbed lock washer (20) against a flat on nut (19) after the nut is securely in place.

o. Install pilot bearing (17) on clutch shaft (70). Bearing and clearance should be 0.06 inch. Insert grease fitting (21) through the hole in the clutch housing and secure in place with lock washer (23) and jam nut (22).

p. Adjust the clutch assembly using the following procedure:

(1) With the clutch disengaged, turn the clutch until the adjusting lock pin (28) can be reached through the inspection hole in the clutch housing. Pull the pin out, and lock in "out" position by inserting a piece of wire or small nail through the cross-drilled hole in the pin.

(2) Turn the adjusting yoke assembly in a clockwise direction one or two adjusting holes, or until the hand lever requires a distinct pressure.

(3) Remove the piece of wire or nail from the adjusting lock pin, and engage the lock pin in the nearest locking hole.

(4) Engage and disengage the clutch several times to make certain the clutch is functioning properly. If proper adjustment has not been accomplished, repeat steps (1) through (3) until proper engagement and disengagement is obtained.

q. Install a new gasket (55) with cover (54) and secure with screws (53).

r. Press bearing (71) into the bore of gear housing (72). Press shaft (13) into housing (14), making sure bearing (14) is firmly against shaft shoulder. Insert shaft and bearing assembly into ring gear (15). Install key (11) and install entire assembly into position into bearing (71). Secure with setscrew (12).

s. Install gear cover (9) and secure with screws (8). Install seal (10) and plug (7). Install gauge tube (64), gauge (63), breather pipe (62) and breather housing (61).

5-6. Installation

a. Refer to paragraph 2-11 and install the reduction gear assembly as instructed.

b. Install clutch lever (4) and secure with screws (1), lock washers (2) and nuts (3).

NOTE

It is recommended after a new reduction gear assembly has been installed on the engine, or when the bearings have been adjusted, to tap the shaft on the end to relieve any preloading that may result due to resistance of the pilot bearing when it is pressed into the flywheel.

c. Lubricate and fill gear housing with oil in accordance with appropriate lubrication order.

Section II. REPAIR OF CRANE PROPELLER SHAFT

5-7. Description

The propeller shaft connects the reduction gear output shaft to the worm shaft as shown in figure 5-1.

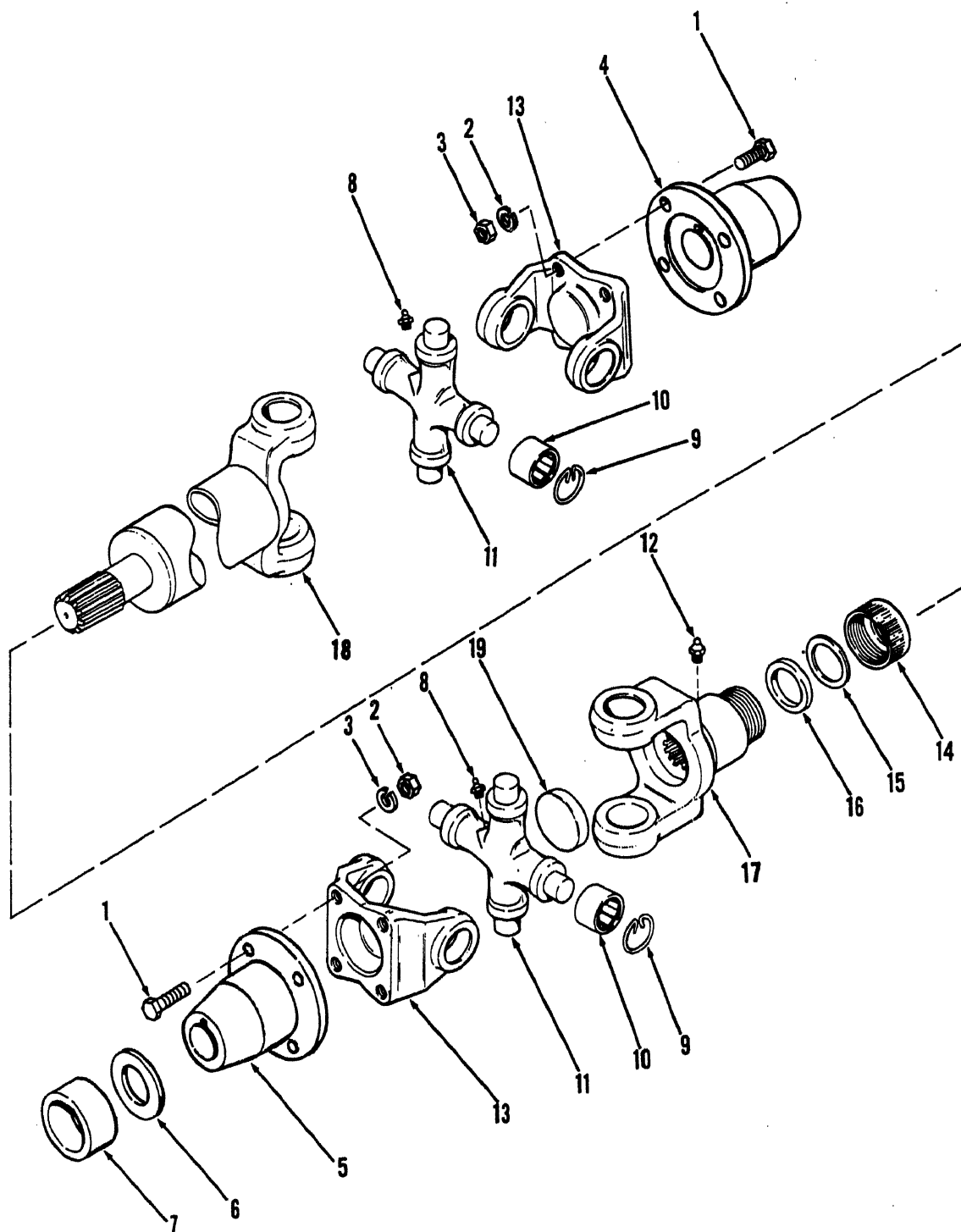
5-8. Removal

Remove propeller shaft in accordance with instructions

given in TM 5-3810-295-12.

5-9. Disassembly

Disassemble the crane propeller shaft in the order shown in figure 5-3.



TA033197

- 1 Cap screw (8)
- 2 Lock washer (8)
- 3 Nut (8)
- 4 Companion flange
- 5 Companion flange

- 6 Washer
- 7 Spacer
- 8 Lubrication fitting (2)
- 9 Retaining ring (8)
- 10 Roller bearing (8)

- 11 Journal assembly (2)
- 12 Lubrication fitting
- 13 Flange yoke (2)
- 14 Dust cap
- 15 Washer

- 16 Cork washer
- 17 Sleeve yoke
- 18 Shaft
- 19 Plug

Figure 5-3. Propeller shaft assembly—exploded view.

5-10. Cleaning, Inspection and Repair

Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent, before inspecting. Replace all worn or damaged parts, and always replace cork washer (16). Check for damaged threads and replace retaining rings that have a permanent set.

5-11. Reassembly

Assemble the crane propeller shaft in accordance with figure 5-3.

5-12. Installation

Install the propeller shaft in accordance with instructions given in TM 5-3810-295-12.

Section III. REPAIR OF CRANE WORM SHAFT**5-13. Description**

The worm shaft drives the boom hoist shaft worm wheel, as shown in figure 5-1.

5-14. Removal

Disconnect the propeller shaft from the worm shaft.

5-15. Disassembly

Refer to figure 5-4 and disassemble the worm shaft as

follows:

- a. Remove cotter pin (1), nut (2), key (3) and flange coupling (4). Nut (5) and lock washer (6) are removed when the assembly is removed from the machine.
- b. Remove retainer (7) and oil seal (11).
- c. Remove shims (8), (9) and (10). Remove shaft (13) from worm sleeve (15). Remove bearings (12) and (14).

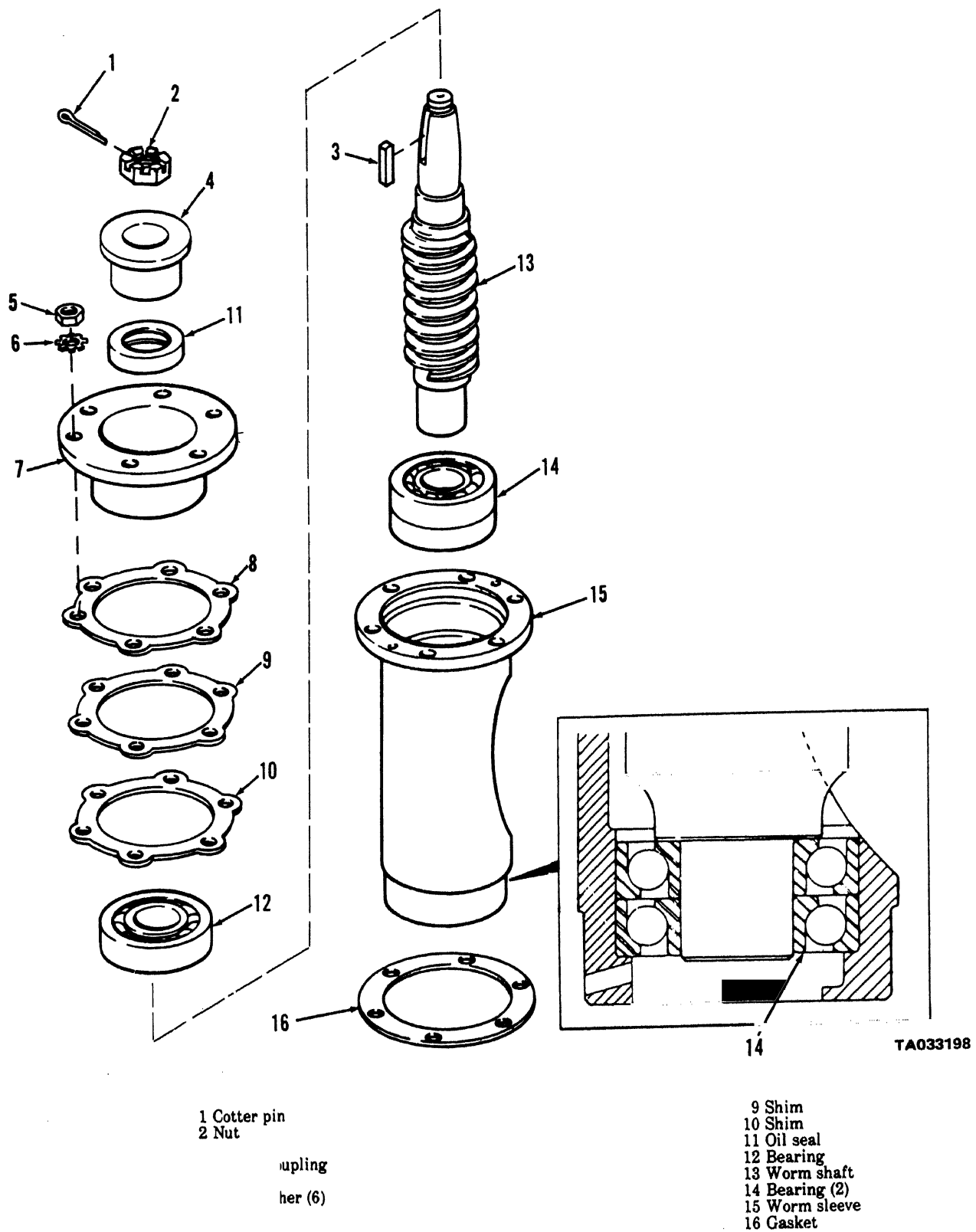


Figure 5-4. Worm shaft assembly—exploded view.

5-16. Cleaning, Inspection and Repair

Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent, before inspecting. Inspect worm shaft for signs of excessive wear, and replace gasket (16). Replace shims (8), (9) and (10) unless shims are in very good condition. Be sure the replacement shims are of the same measured thickness as the discarded shims to assure proper shaft end clearance of 0.003 to 0.005 inch. If replacement bearings are available, replace bearings (12) and (14). Clean key (3) using a fine file if necessary, and be sure it fits snugly in the shaft (13) keyway.

5-17. Reassembly

Refer to figure 5-4 and assemble the worm shaft as follows:

- a. Preheat bearings (12) and (14) in an oil bath and install bearings on proper ends of shaft (13).

NOTE

Bearings (14) are thrust bearings and must be assembled so that the thrust is absorbed in the

proper direction. Refer to insert illustration in figure 5-4.

- b. Install assembled shaft (13) and bearings into worm sleeve (15). Be sure bearings (14) are firmly against the inner shoulder in the worm sleeve as shown in the insert illustration.

- c. Install oil seal (11) into retainer (7). Be sure that the sealing surface of shaft (13) is clean and free of burrs, and that the seal (11) wiper lips face inward, toward the worm portion of shaft (13).

- d. Install gasket (16) on the chain case on which the worm sleeve is mounted. Install shims (8), (9) and (10) on the face of worm sleeve (15). Place retainer (7) in the bore of sleeve (15).

- e. Install key (3) and secure assembly with nut (2) and cotter pin (1).

5-18. Installation

Connect the propeller shaft to the worm shaft.

Section IV. REPAIR OF BOOM HOIST SHAFT

5-19. Description

The boom hoist shaft drives the rear drumshaft assembly through a roller chain drive sprocket arrangement from the left end of the boom hoist shaft, as shown in figure 5-1. The boom is raised and lowered under power through a planetary gear arrangement in the boom hoist drum, which is mounted on the right end of the boom hoist shaft. The boom hoist shaft, in turn, is worm gear driven by a propeller shaft and worm gear coupled to the reduction gear output shaft.

5-20. Removal

The boom hoist shaft cannot be removed as an assembly, and must therefore be disassembled in place.

5-21. Disassembly

- a. Refer to TM 5-3810-295-12 and perform the

following steps:

- (1) Lower boom to the ground.
- (2) Remove boom hoist clutch.
- (3) Remove boom hoist brake.
- (4) Remove rear drum chain case and remove the rear drum drive chain.
- (5) Remove cover that provides access to the horizontal swing shaft drive chain. Loosen the drive chain. Remove chains from the horizontal swing shaft sprockets, but do not break the chain at the master links.

- b. After the above has been accomplished the boom hoist shaft may be disassembled as follows. Refer to figure 5-5.

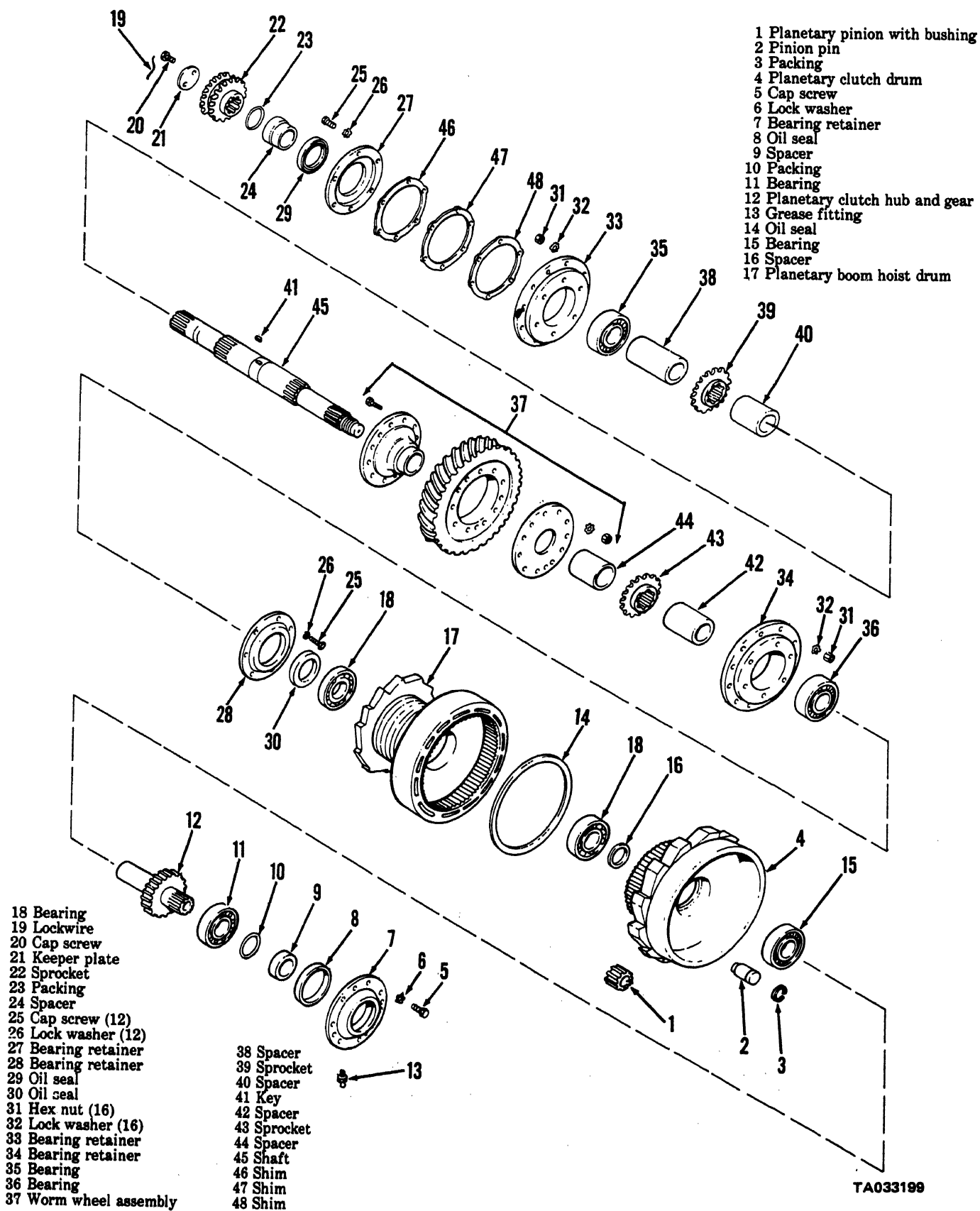


Figure 5-5. Boom hoist shaft assembly—exploded view.

(1) Support boom hoist drum (17) with a suitable ling and slide it off shaft (45) as an assembly. Items 1), (3) through (14), (2), (15) and (18) will come off the shaft with the drum.

(2) At the opposite end of the boom hoist shaft, remove lockwire (19), screws (20), keeper plate (21), sprocket (22), packing (23) and spacer (24).

(3) Place suitable blocking beneath each end of the shaft to prevent the shaft from dropping during the following procedure. Remove bearing retainers (27) and (28) by removing screws (25) and lock washers (26) at each retainer. Oil seals (29) and (30) will come out in the retainers.

(4) Remove nuts (31) and lock washers (32) and remove bearing retainers (33) and (34). Two tapped puller holes are provided in the bearing retainers to facilitate removal.

(5) Remove inner races of bearings (35) and (36) from the shaft using a suitable puller.

(6) Remove sufficient blocking from each end of the shaft to disengage the worm wheel (37) from the worm shaft. All remaining items on the shaft can then be removed by sliding the shaft through the right side of the chain case.

NOTE

Do not disassemble worm wheel assembly (37).

2-22. Cleaning, Inspection and Repair

Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent, before inspecting. Inspect all parts for wear, scoring, cracks, or any other visible signs of damage, and replace all parts not in good condition. Replace all packing, seals, bearings, washers, deformed shims, and other expendable items. Inspect the parts listed in table 1-4 for conformity with maximum clearances and replace any part worn beyond the maximum dimensions listed. Adjust end play by shimming, if necessary, and maintain the clearances listed.

2-23. Reassembly and Installation

a. The boom hoist shaft is reassembled in place as it is installed in the machine.

NOTE

The worm shaft must be installed before the boom hoist shaft can be installed.

(1) Install key (41) and press worm wheel assembly (37) on shaft (45). The faces of wheel assembly (37) must be flush with the shaft (45) shoulder.

(2) Coat worm wheel teeth (37) with a light coating of white lead or Prussia blue. This is used later to adjust the worm wheel-to-worm shaft gear contact. The finished face of the worm wheel must be placed on the right side, as viewed from the rear of the shaft.

(3) Install spacers (40) and (44) and sprockets (39) and (43). The sprockets must be tight against the spacers.

CAUTION

Sprockets (39) and (43) are match marked during manufacture and must be installed in matched pairs. Be sure both sprockets have the same number stamped on the outer face. Be sure that the match marked internal spline on each sprocket mates properly with the marked splines on the shaft.

(4) Install spacers (38) and (42). Warm the inner races of bearings (35) and (36) and install the races on each end of the shaft. The races must be pressed firmly into place in one motion and must bear against spacers (38) and (42) to form a solid assembly.

(5) Install the assembled shaft in the bore in the revolving frame and block it firmly in position with the shaft centered in the bore. Worm wheel must be engaged in the worm shaft.

(6) Install the outer races of bearing (35) and (36) in bearing retainers (33) and (34). Install bearing retainers on shaft (45) and secure with nuts (31) and lock washers (32) on each bearing retainer.

(7) Assemble oil seals (29) and (30) into retainers (27) and (28). Be sure the seals are installed with the springs facing sprockets (39) and (43) and that the areas between the seal lips are packed with the GAA lubricant. Check seal surfaces of the shaft for nicks and burrs. Minor imperfections on the shaft can cause rapid seal wear.

(8) Install shims (46), (47) and (48) in equal amounts between bearing retainers (27) and (28), and retainers (33) and (34) so that shaft end play is between 0.003 and 0.005 inch, using a dial indicator. Install the two bearing retainers (27) and (28) using screws (25) and lock washers (26).

(9) Adjust worm wheel-worm shaft backlash as follows:

(a) Turn the worm shaft through one complete revolution.

(b) Check points of contact between the worm and worm wheel (37). Under no load conditions, all contact must be to the left of the center of the worm shaft.

NOTE

Tooth contact must be checked by removing the inspection plate, and it must be checked at the bottom of the worm wheel.

(c) If all contact is not on the left side of the worm shaft, move shims (46), (47) and (48) as required to a point beneath the opposite bearing retainer until proper contact is accomplished. Then recheck boom hoist shaft end play.

(d) Use a suitable sealing compound, such as Permatex No. 2 on screws (25) and lock washers (26) and adjacent sealing surfaces.

(10) Assemble the boom hoist drum (17) as follows:

(a) Position drum (17) on the workbench, with ratchet side up. Pack drum with grease, type GAA, as described in the current LO 5-3810-295-12 (series).

(b) Tap bearing (18) into the drum until it is firmly seated against the drum shoulder. Turn drum over and finish packing the drum cavity with grease. Install bearing (15) in this end of the drum. Place spacer (16) on top of bearing (15).

(c) Install oil seal (14) in drum (17). Pack seal with type GAA grease and be sure the sealing lip points inward.

(d) Install pinions (1) in drum (4) and position drum (4) on drum (17).

(e) Lubricate packing (3) and install them on pinion pins (2). Install pins (2) in pinion (1). Turn pins so that the flats on the outer ends of the pins allow bearing retainer (7) to be installed. Install oil seal (8) in bearing retainer (7). Be sure the sealing lip points inward, and pack the seal with type GAA grease as described in the current LO 5-3810-295-12 (series).

(f) Warm and install bearing (15) on the elongated hub of planetary clutch hub and gear (12). Warm and install bearing (11) on the opposite end of planetary hub and gear (12). Install packing (10) on planetary hub and gear (12).

(g) Install planetary clutch hub and gear (12) with bearings (15) and (11), and packing (10) on planetary clutch hub and gear (12).

(h) Install retainer (7) with grease fitting (13)

in place on the retainer. Secure retainer with screws (5) and lock washer (6).

(i) Carefully slide spacer (9) into position against bearing (11). Using a suitable hoist, lift the assembled drum and install it as an assembly on the right end of the shaft.

(11) Refer to TM 5-3810-295-12 and perform the following operations:

(a) Install boom hoist brake band and adjust as instructed.

(b) Install boom hoist clutch and adjust as instructed.

(c) Open hydraulic reservoir shut off valve and bleed hydraulic lines to the boom hoist clutch and boom hoist brake.

(d) Install rear drum chain case and the rear drum drive chain and adjust chain tension as instructed.

(e) Adjust horizontal swing shaft chain tension. Be sure all chains are properly mounted on all sprockets before tightening eccentric adjusting shafts. Install chain access cover.

CAUTION

Be sure no hydraulic fluid comes into contact with brake clutch linings during repair.

Section V. REPAIR OF REAR DRUMSHAFT

5-24. Description

The rear drumshaft is used two ways: 1) as the secondary load line during crane type operation, and 2) as the hoist drum for digging operations. The drumshaft is driven from the boom hoist shaft through a double-strand roller chain, located in the rear drumshaft drive chaincase on the left rear of the crane. (Refer to fig. 5-1.)

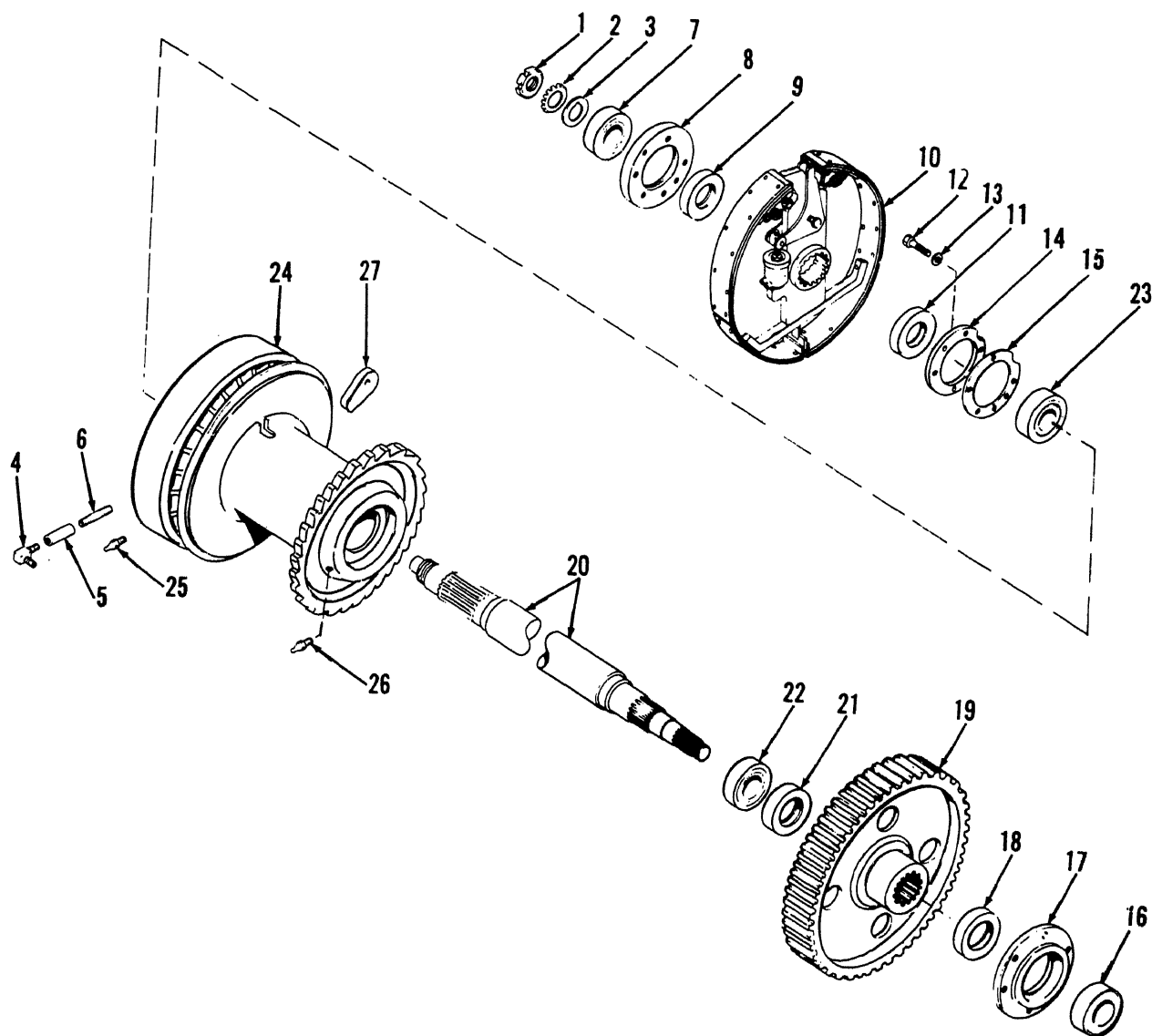
5-25. Removal

The rear drumshaft is removed as an assembly in accordance with paragraph 2-12.

5-26. Disassembly

NOTE

Rear drumshaft disassembly is shown in figure 5-6.



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- 1 Nut
- 2 Lock washer
- 3 Keyed washer
- 4 Male elbow
- 5 Pipe coupling
- 6 Pipe nipple
- 7 Bearing
- 8 Retainer
- 9 Seal

- 10 Clutch assembly
- 11 Seal
- 12 Cap screw (8)
- 13 Lock washer (8)
- 14 Retainer
- 15 Gasket
- 16 Bearing
- 17 Retainer
- 18 Seal

- 19 Gear
- 20 Shaft
- 21 Seal
- 22 Bearing
- 23 Bearing
- 24 Drum
- 25 Grease fitting
- 26 Grease fitting
- 27 Wedge

Figure 5-6. Rear drumshaft assembly—exploded view.

a. Remove nut (1), lock washer (2) and keyed washer (3). Remove male elbow (4), pipe coupling (5) and pipe nipple (6).

b. Using a suitable puller, remove bearing (7) from shaft (20). Remove retainer (14) and gasket (15).

c. Using a suitable puller, remove bearing (16), and retainer (17) and seal (18). Pull gear (19) from drum (24).

CAUTION

Shaft (20) must be pressed out from left to right, as shown in the illustration.

d. Bearing (22) and seal (21) will come out with the shaft. Remove bearing and seal from the shaft. Remove bearing (23) from the opposite end of the drum. Remove fittings (25) and (26), and wedge (27).

5-27. Cleaning, Inspection and Repair

a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent. Replace all seals, gaskets, and deformed shims.

b. Inspect all parts for wear, scoring, cracks, or any other visible indications of damage. Replace any defective parts. Inspect gear teeth for excessive wear, pitting, or tooth shortening. Check roots of all rear teeth for signs of cracking.

c. Inspect and smooth all seal seating surfaces with a fine oil stone.

d. Worn sprockets should be replaced. However, if this is necessary, also replace the drive chain.

e. Repair clutch (10, fig. 5-6) as follows:

(1) Refer to figure 5-7. When clutch lining (37) is worn to within one-sixteenth of an inch of rivets (36) at

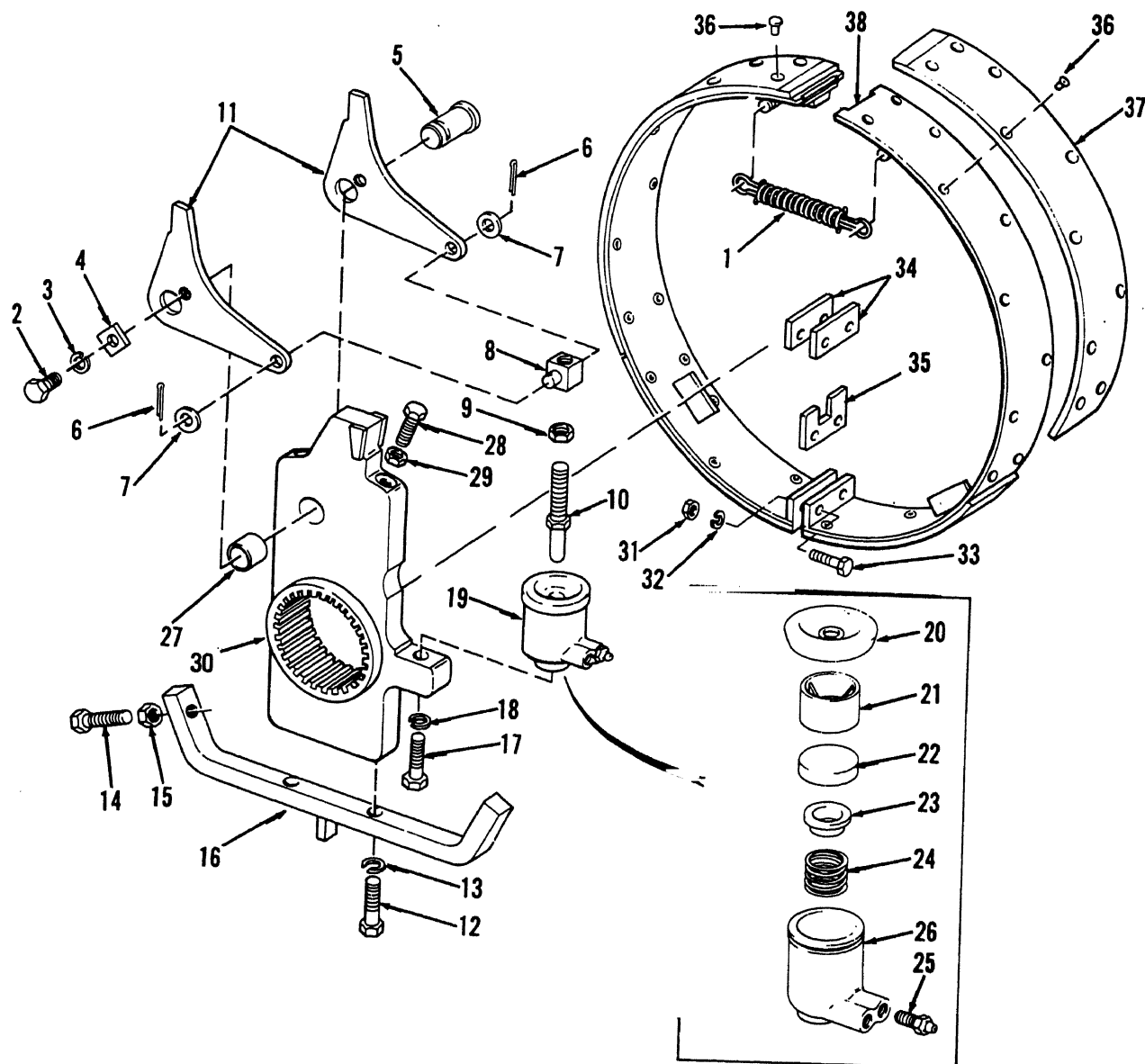
any place on the lining, new linings must be installed.

(2) Boot (20) and cup (22) can be replaced if the hydraulic cylinder (items 20 through 26) leaks. If this does not stop the leak, the entire hydraulic cylinder must be replaced.

(3) If clutch lining wear is apparent on only one end of the lining, the linings may be reversed and reinstalled without relining.

(4) All items should be inspected for signs of wear or damage, and replacement should be made as necessary. Spring (1) should be compared with a new spring. If cracks, elongation, or deformation are evident, the spring should be replaced.

(5) If adjustment of push rod (10) is insufficient, another plate (35) may be added to allow further adjustment.



TA203515

- 1 Spring
- 2 Cap screw
- 3 Lock washer
- 4 Keeper plate
- 5 Pin
- 6 Cotter pin (2)
- 7 Washer (2)
- 8 Trunnion
- 9 Nut
- 10 Adjusting pushrod
- 11 Lever
- 12 Cap screw (2)
- 13 Lock washer (2)

- 14 Cap screw (2)
- 15 Nut (2)
- 16 Band guide
- 17 Cap screw
- 18 Lock washer
- 19 Cylinder assembly
- 20 Boot
- 21 Piston
- 22 Cup
- 23 Spring seat
- 24 Spring
- 25 Bleeder fitting

- 26 Cylinder body
- 27 Bushing
- 28 Cap screw
- 29 Nut
- 30 Spider
- 31 Nut (2)
- 32 Lock washer (2)
- 33 Cap screw (2)
- 34 Plate (2)
- 35 Plate
- 36 Rivet (20)
- 37 Clutch lining (2)
- 38 Clutch band (2)

Figure 5-7. Front and rear drum clutch assembly—exploded view.

5-28. Reassembly

a. Refer to figure 5-6. Block drum (24) to prevent it from rotating, and install shaft (20) in the drum. Prepack bearings (23) and (22) with GAA grease, and install the bearings on shaft (20). Apply force to the inner races only, and be sure the bearings are firmly against the shaft shoulders.

b. Lubricate all seals with GAA grease, and install the seals (9, 11, 21, and 18) in their respective retainers. Note that seal (21) must be installed in drum (24) bore.

c. Install retainer (14) and gasket (15) with screws (12), lock washers (13).

d. Install clutch assembly (10). Be careful not to damage seal (11) as the clutch spider is pressed into position against bearing (23). Note that repair of the clutch assembly is discussed in the next section of this manual. All repairs to the clutch assembly should be made at this time.

e. Install retainer (8) and seal (9) on the hub of clutch (10). Install the inner race of bearing (7) on the shaft, making sure the race butts firmly against the

clutch spider hub.

f. Prepack inner race of bearing (7) with GAA grease. Install keyed washer (3), lock washer (2) and nut (1). Place outer race of bearing (7) over the inner race to prevent foreign matter from entering the lubricant.

g. Install gear (19) on the shaft. Be sure that the gear hub is firmly against bearing (22). Note that the gear hub extends through seal (21). Be careful that seal (21) is not damaged during installation of the gear.

h. Install retainer (17) and seal (18) in place on the shaft. Heat and install the inner race of bearing (16), with the inner race firmly against the hub of gear (19). Prepack the bearing inner race with GAA grease and slide the outer race of the bearing over the inner race to keep the lubricant clean.

i. Install lubricant fittings (25) and (26), and male elbow (4), pipe coupling (5) and pipe nipple (6).

5-29. Installation

Refer to paragraph 2-12 and install the rear drumshaft in the crane.

Section VI. REPAIR OF FRONT DRUMSHAFT

5-30. Inspection

The front drumshaft is used in two ways: 1) as the primary load line in crane operations, and 2) as the digging drum for shovel operations. For digging operations (shovel) the front drumshaft is equipped with sprocket-type lagging (refer to fig. 5-1).

5-31. Removal

The front drumshaft assembly is removed in accordance with instructions given in paragraph 2-13.

5-32. Disassembly

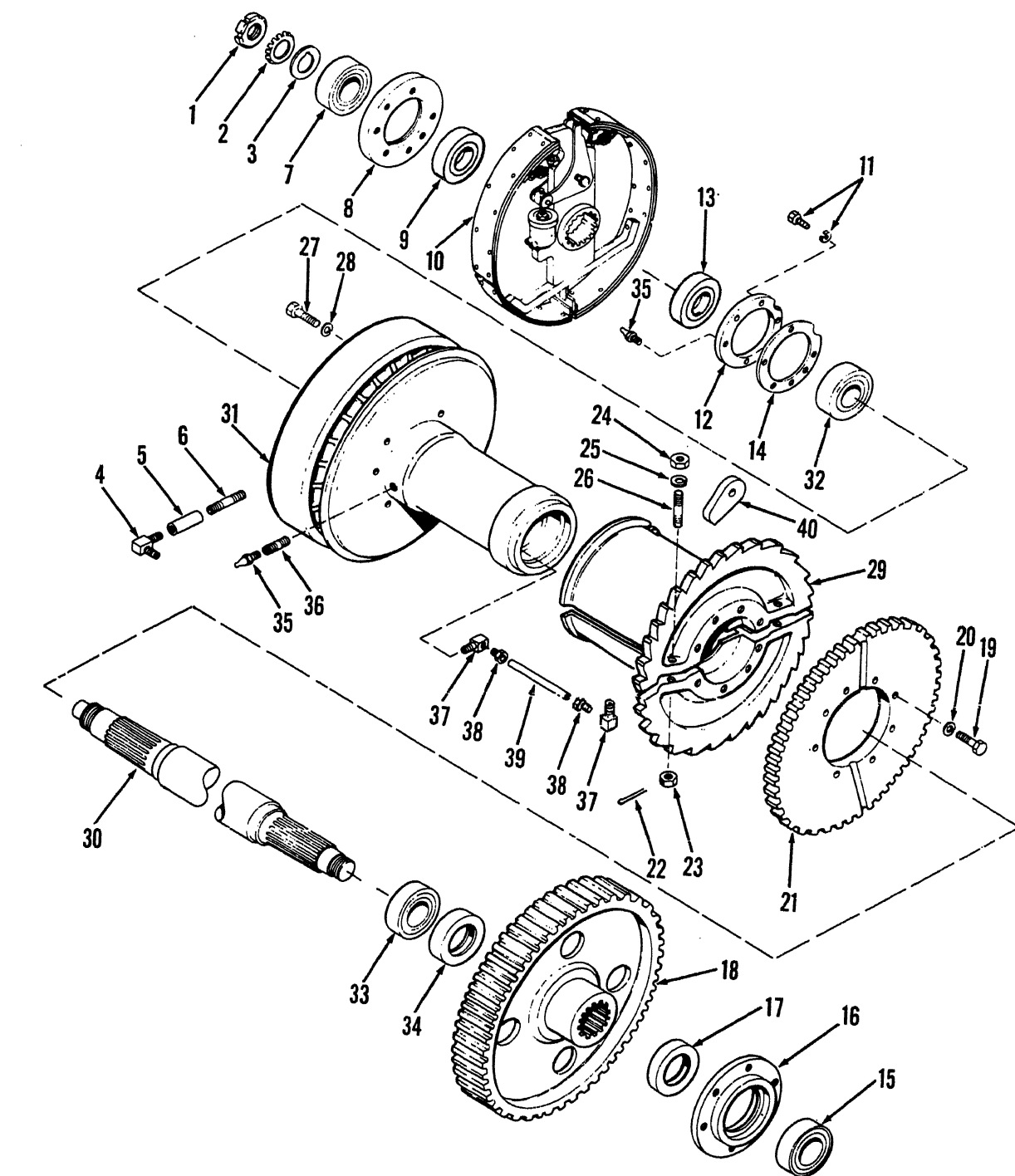
Disassembly of the front drumshaft is as follows (refer to fig. 5-8):

a. Remove nut (1), lock washer (2) and keyed washer (3). Remove male elbow (4), pipe coupling (5) and pipe nipple (6).

b. Remove bearing (7) from shaft (30), using a suitable puller. Slide retainer (8) and seal (9) off the shaft as an assembly.

c. Slide clutch assembly (10) off the shaft as an assembly. Note that the front clutch assembly is identical to the rear clutch assembly. Procedures for repairing this assembly are presented in paragraph 5-27.

d. Remove screws (11) and then slide retainer (12) and seal (13) off the shaft. Remove and discard gasket (14). Remove retainer (16) and seal (17).



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- | | | | |
|--------------------|---------------------|--------------------|-------------------|
| 1 Nut | 11 Cap screw (6) | 21 Sprocket | 31 Drum |
| 2 Lock washer | 12 Retainer | 22 Cotter pin (2) | 32 Bearing |
| 3 Keyed washer | 13 Seal | 23 Nut (2) | 33 Bearing |
| 4 Male elbow | 14 Gasket | 24 Nut (2) | 34 Seal |
| 5 Pipe coupling | 15 Bearing | 25 Washer (2) | 35 Grease fitting |
| 6 Pipe nipple | 16 Retainer | 26 Stud (2) | 36 Pipe nipple |
| 7 Bearing | 17 Seal | 27 Cap screw (8) | 37 Elbow (2) |
| 8 Retainer | 18 Gear | 28 Lock washer (8) | 38 Fitting (2) |
| 9 Seal | 19 Cap screw (10) | 29 Spit lagging | 39 Tube |
| 10 Clutch assembly | 20 Lock washer (10) | 30 Shaft | 40 Wedge |

Figure 5-8. Front drumshaft assembly—exploded view.

e. Then, from the opposite end of the shaft, pull bearing (15) from the shaft. Remove the gear (18).

f. Remove screws (19) and lock washers (20) and slide sprocket (21) from the shaft.

g. Remove cotter pins (22), nuts (23), nuts (24), washers (25) and studs (26). Remove screws (27) and lock washers (28) located inside clutch housing. Remove split lagging (29).

h. Press shaft (30) from drum (31). Shaft may be pressed in either direction. Either bearing (32) or bearing (33) and seal (34) will come off the shaft, depending on the direction of the press. Remove the remaining items from the shaft.

5-33. Cleaning, Inspection and Repair

a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent. Replace all seals, gaskets, deformed shims, and any damaged or deformed threaded parts.

b. Inspect all parts for wear, scoring, cracks, or any other visible indications of damage or excessive wear. Inspect gear and sprocket teeth for severe wear, pitting or cracks, especially at the roots of the gear teeth.

c. Inspect and smooth all seal seating surfaces with a fine oil stone or crocus cloth.

d. Repair of the front drum clutch is identical to that for the rear drum, except for the spider. The spider is reversed in the two drums to allow for opposite drumshaft rotation.

5-34. Reassembly

a. Place drum (31) on a suitable stand and secure the drum so it cannot move. Place shaft (30) into the drum so that the shaft is centered axially in the bore. Prepack bearings (32) and (33) with GAA grease and install the bearings on the shaft. Be sure the bearings are firmly against the shaft shoulders. Apply force only to the inner race of the bearings.

b. Lubricate and install seal (34) in drum (31). Lubricate seals (9), (13) and (17), and install the seals

in their respective retainers.

c. Install gasket (14) and retainer (12) with seal (13) in the retainer. Secure the retainer with screws (11).

d. Install clutch (10). Install retainer (8) with seal (9) in place in the retainer on the hub of the clutch spider.

e. Heat inner races of bearings (7) in oil bath, and install the bearing race on shaft (30). Be sure the race is firmly against the shaft hub. Prepack the inner race of the bearing with GAA grease, and place the outer race of bearing (7) over the inner race to prevent contamination of the lubricant.

f. Install keyed washer (3), lock washer (2) and nut (1) on the shaft. Place split lagging (29) over the hub of drum (31).

g. Install fitting (35), nipple (36), elbow (37), fitting (38) and tube (39). Be sure to install both elbows at the ends of the tube to provide lubricant to both bearing (32) and (33).

h. Secure split lagging (29) in position using nuts (24), washers (25), studs (26), nuts (23) and cotter pins (22). Install screws (27) and lock washers (28) around periphery of drum (31), extending into lagging (29).

i. Install gear (18) firmly against bearing (33). Be careful to avoid damaging seal (34) when pushing the hub of gear (18) through the seal.

j. Place retainer (16) with seal (17) on the shaft. Warm the inner race of bearing (15) and install the race firmly against seal (17). Prepack the bearing inner race with GAA grease and install the outer race over the inner race to prevent contamination of the lubricant.

5-35. Installation

Refer to paragraph 2-13 and install the front drumshaft assembly.

CAUTION

Be sure the marked holes in the clutch spider lines up with the hole in the shaft to assure lubrication of shaft bearings.

Section VII. REPAIR OF REVERSING SHAFT

5-36. Description

The reversing shaft reverses the direction of rotation of the front drumshaft (main load line) to provide powered load lowering. Drum reversal is accomplished by engaging the reversing shaft clutch with the front drum clutch disengaged. Because the reversing shaft is driven directly from the front drumshaft gear, the direction of rotation imparted to the front drumshaft is reversed. When the reversing shaft clutch is engaged (refer to fig. 5-1), the front drumshaft is driven by a chain and sprocket arrangement from the reversing shaft.

5-37. Removal

Remove the reversing shaft in accordance with instruc-

tions given in paragraph 2-14.

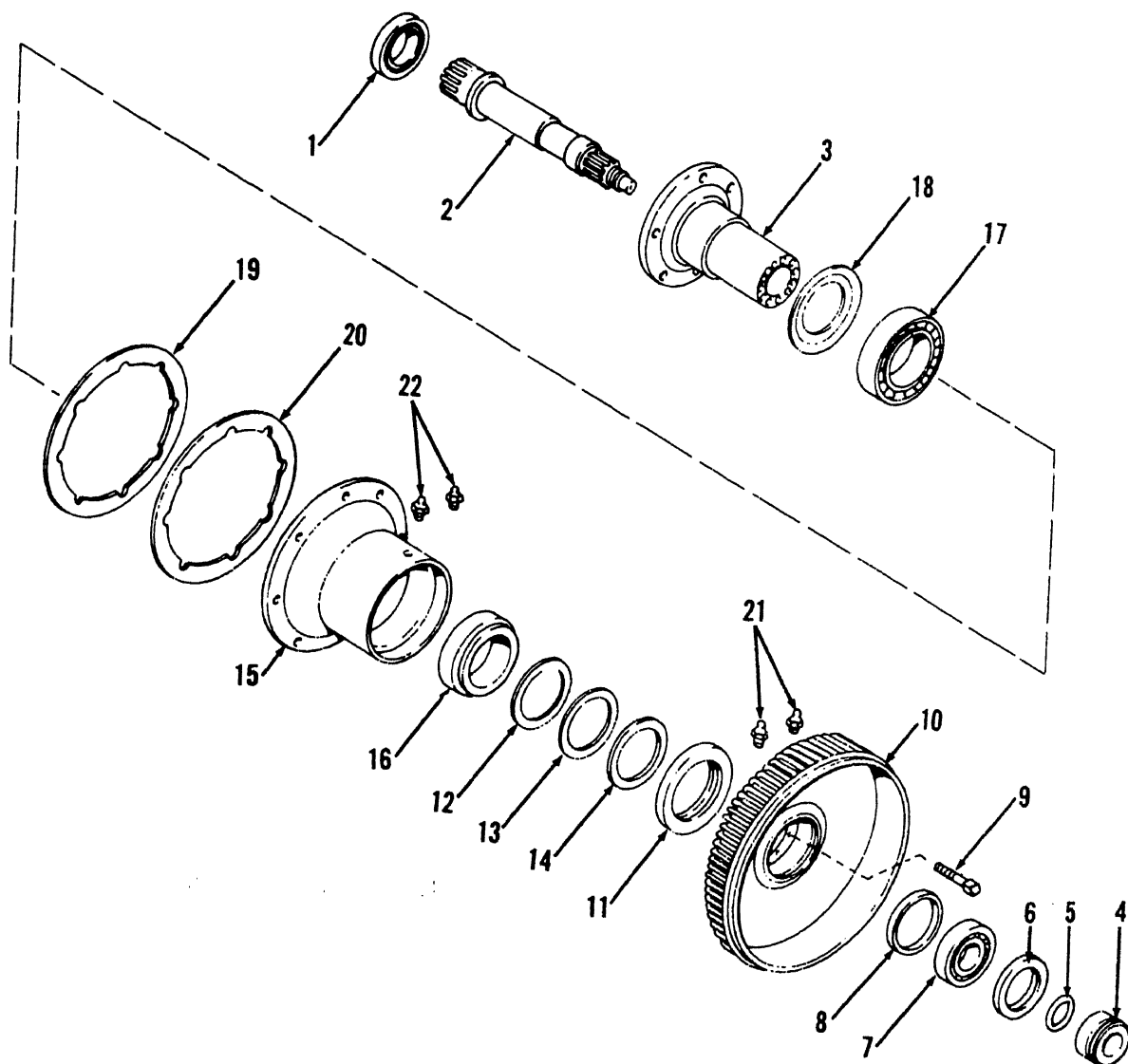
5-38. Disassembly

Disassemble the reversing shaft as follows (refer to fig. 5-9):

a. Place the assembly on end on suitable wooden blocking, or a stand, with hub (3) facing downward. Press shaft (2) out of the assembly in the direction shown. Bearing (1) will come off with the shaft. Remove bearing (1) from the shaft.

b. Remove spacer (4), packing (5) and seal (6). Remove bearing (7) and lock ring (8).

c. Remove screws (9) and drum (10). Remove seal (11) from the drum.



TA033203

- 1 Bearing
- 2 Shaft
- 3 Reversing shaft hub
- 4 Spacer
- 5 Packing
- 6 Seal
- 7 Bearing
- 8 Lock ring
- 9 Cap screw (12)
- 10 Reversing shaft drum
- 11 Seal

- 12 Shim
- 13 Shim
- 14 Shim
- 15 Reversing clutch housing
- 16 Bearing
- 17 Bearing
- 18 Bearing seal
- 19 Shim
- 20 Shim
- 21 Grease fitting (2)
- 22 Relief fitting (2)

Figure 5-9. Reversing shaft assembly—exploded view.

d. Remove shims (12), (13) and (14). If the shims are in good condition, tie them together in the order in which they were disassembled. If they are not in good condition, measure and record their total thickness for use during assembly.

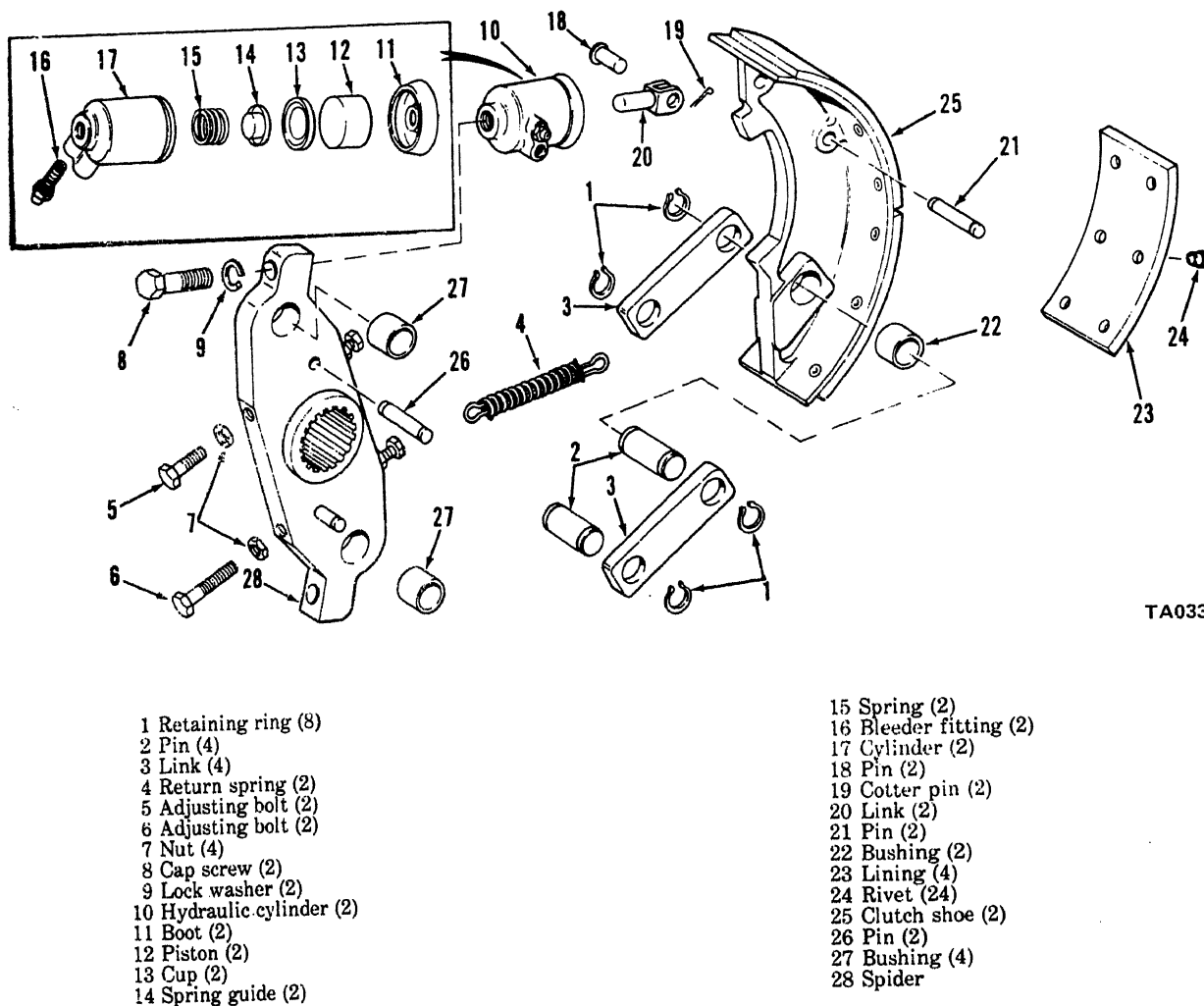
e. Press reversing shaft hub (3) out of clutch housing (15), pressing on the end of the hub which is tapped for screws (9). Bearing (6) will remain in the housing, but the inner race of bearing (17) will come off with hub (3).

f. Remove shims (19) and (20), grease fittings (21)

and relief fittings (22).

g. Figure 5-10 illustrates disassembly of the reversing shaft clutch. The identical clutch is also used for

the horizontal swing shafts. The procedures apply to both clutches. Two hydraulic cylinders and clutch shoes are provided, but only one is illustrated for simplicity.



TA033204

- 1 Retaining ring (8)
- 2 Pin (4)
- 3 Link (4)
- 4 Return spring (2)
- 5 Adjusting bolt (2)
- 6 Adjusting bolt (2)
- 7 Nut (4)
- 8 Cap screw (2)
- 9 Lock washer (2)
- 10 Hydraulic cylinder (2)
- 11 Boot (2)
- 12 Piston (2)
- 13 Cup (2)
- 14 Spring guide (2)

- 15 Spring (2)
- 16 Bleeder fitting (2)
- 17 Cylinder (2)
- 18 Pin (2)
- 19 Cotter pin (2)
- 20 Link (2)
- 21 Pin (2)
- 22 Bushing (2)
- 23 Lining (4)
- 24 Rivet (24)
- 25 Clutch shoe (2)
- 26 Pin (2)
- 27 Bushing (4)
- 28 Spider

Figure 5-10. Reversing shaft and horizontal swing shaft clutch assemblies—exploded view.

5-39. Cleaning, Inspection and Repair

a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent. Replace all seals, gaskets, deformed shims, and packings.

b. Inspect all parts for wear, scoring, cracks, or any other visible signs of damage or deterioration. Replace any parts not in good condition. Inspect and smooth all seal seating surfaces with a fine oil stone or crocus cloth.

c. Repair clutch as follows:

(1) Clutch linings must be repaired when the linings (item 23, fig. 5-10) are worn to within one sixteenth of an inch of the rivet heads at any point. If wear is concentrated on one end of the brake shoe, the shoes may be reversed. If this has already been done

before, the rivets must be drilled out and the linings must be replaced.

(2) If the hydraulic cylinder (10) leaks, boot (11) and cup (13) can be replaced. If this does not resolve the leak, the entire cylinder should be replaced as a unit.

(3) All clutch parts must be inspected for signs of wear or damage. Items with damaged threads should be replaced. Compare spring (4) with a new spring of the same type. If the spring is elongated or deformed, replace the spring.

5-40. Reassembly

a. Refer to figure 5-9 and install bearing seal (18) on hub (3). Warm inner race of bearing (17) and install it on hub (3). Install the outer race of the bearing in housing (15). Pack bearing (17) inner race with GAA grease.

b. Place hub (3) on end, large end down. Install outer race of bearing (16) in housing (15).

c. Install housing (15) on hub (3) and pack the space between bearings (17) and (16) with GAA grease. Warm the inner race of bearing (16) and install the race over outer diameter of hub (3). Exact location on the hub is not important at this time.

d. Warm bearing (1) and install it on shaft (2). Apply force to the inner race only, and be sure race is firmly against the shaft shoulder.

e. Install shaft (2) and bearing (1) in hub (3), with the bearing firmly against the shoulder of hub (3). Refer to figure 2-7 and install sprocket, end plate, and end plate screws as shown. Do not lockwire the screws because they will be removed later in this assembly procedure.

f. Assemble drum (10, fig. 5-9) on hub (3) using three screws (9) spaced in even intervals. Tighten screws to 20 to 25 ft-lb (27—34 N · m) using a torque wrench, and check shaft end play with a dial indicating micrometer. Remove drum (10) and install sufficient number of shims (12), (13) and (14) to allow end play of 0.003 to 0.005 inch.

g. Press seal (11) into the bore of clutch housing (15).

Pack sealing lips with GAA grease and install the seal with the spring pointing toward the drum (10). Remove sprocket, end plate, and end plate screws installed previously.

h. Install drum (10) using screws (9). Tighten screws to 20 to 25 ft-lb (27—34 N · m). Install lock ring (8). Be sure holes in the lock ring line up with grease fittings (21). Install relief fittings (22).

i. Install lock ring (8) with the holes in the ring located in line with the grease fittings (21). Install relief fittings (22).

j. Warm bearing (7) in an oil bath and install it firmly against lock ring (8).

k. Prepack seal (6) with GAA grease and press the seal into position on the drum (10). Be sure seal lip is toward bearing (7).

l. Install packing (5) in spacer (4). Lubricate the bore of spacer and O-ring, and slide the assembled items into position on shaft (2). Be careful to avoid damage to the seal as the spacer enters the seal.

5-41. Installation

Refer to paragraph 2-14 and install the reversing shaft assembly.

Section VIII. REPAIR OF HORIZONTAL SWING SHAFT

5-42. Description

The horizontal swing shafts (left and right) are identical in construction, and are located on each side of the vertical swing shaft as shown in figure 5-1. The left horizontal swing shaft clutch turns the revolving frame to the right. The right horizontal swing shaft clutch turns the revolving frame to the left.

5-43. Removal

Remove the horizontal swing shaft in accordance with instructions given in paragraph 2-15.

5-44. Disassembly

a. Refer to figure 5-11 and remove lockwire (1), screws (2) and washer (3). Remove bevel pinion (4) from shaft (7) and remove spacer (5).

b. Place the assembly on end, with sprocket end of the hub and sprocket (8) facing downward. Be sure blocking is high enough to allow shaft (7) to be pressed out of the bottom of hub (8). Bearing (6) will come off on

shaft (7). Remove bearing (6) from the shaft.

c. Remove bearing (9), packing (10) and seal (11). Remove bearing (12) from bore of drum (13) using a suitable puller. Remove lock ring (14).

d. Remove screws (15) and remove drum (13) and seal (16). Remove shims (17), (18) and (19).

e. Block housing (20) and press hub and sprocket (8) from the housing. Press on the end of the hub which is tapped for screws (15). Bearing (21) will remain in the housing and the inner race of bearing (22) will come off on the hub.

f. Remove remaining items, seal (23), fittings (27) and relief fittings (28) from the assembly. Shims (25) and (26), and packing (24) are removed when the assembly is removed from the machine.

g. Refer to paragraph 5-39c for disassembly and repair instructions for the horizontal swing shaft clutch.

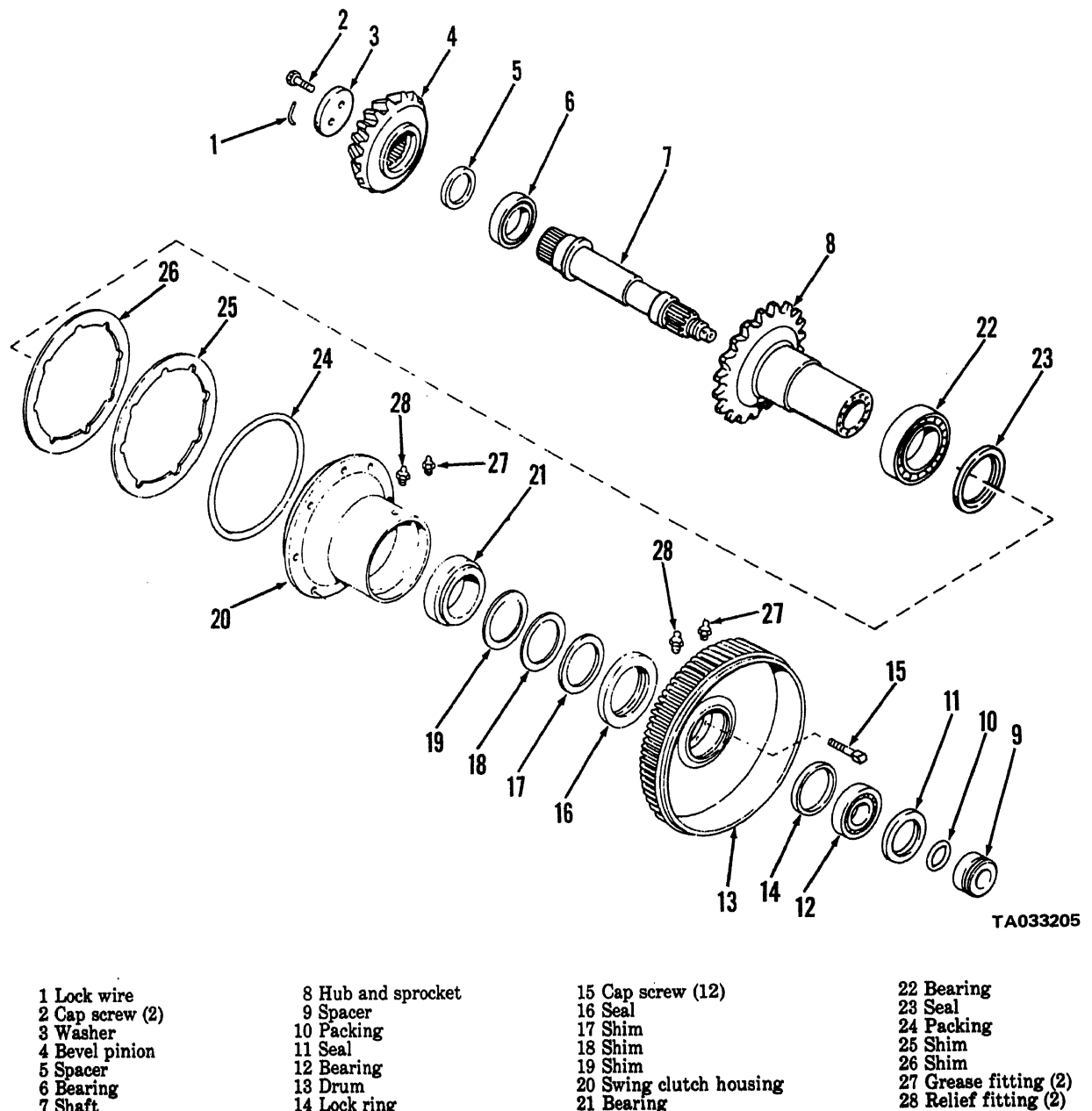


Figure 5-11. Horizontal swing shaft assembly—exploded view.

5-45. Cleaning, Inspection and Repair

a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent, before inspecting.

b. Replace all seals, gaskets, deformed shims, packing, and other expendable parts.

c. Inspect all parts for wear, scoring, cracks, or any other visible signs of damage or excessive wear. Replace any parts not in good condition. Inspect gear teeth for severe wear, pitting, and cracks, especially at the roots of the teeth.

d. Inspect and smooth all seal seating surfaces with a fine oil stone or crocus cloth.

e. The horizontal swing shafts use the identical clutch as the reversing shaft assembly. Refer to paragraph 5-39c for clutch repair.

5-46. Reassembly

a. Refer to figure 5-11 and install seal (23) and packing (24) in housing (20).

b. Warm inner race of bearing (22) in oil bath and install the race on hub and sprocket (8). Pack the inner race of bearing (22) with GAA grease, and install the

outer race of the bearing and seal (23) in clutch housing (20).

c. Place hub and sprocket (8) on end, with the sprocket end down. Install the outer race of bearing (21) in clutch housing (20).

d. Install clutch housing (20) on hub and sprocket (8). Pack area between seal (23) and bearing (21) with type GAA grease. Warm and install the inner race of bearing (21) over the outer diameter of hub and sprocket (8).

e. Warm bearing (6) and install the bearing on shaft (7). Be sure to apply force only to the inner race of the bearing, and be sure bearing is seated firmly against the shaft shoulder.

f. Install shaft (7) and bearing (6) into hub and sprocket (8). Be sure bearing (6) is firmly against the shoulder in hub and sprocket (8).

g. Install spacer (5) and bevel pinion (4). Secure with washer (3), screws (2) and lock wire (1).

h. Temporarily assemble drum (13) on hub (8) using three screws (15) evenly spaced. Do not install shims at this time. Tighten the screws to 20 to 25 ft-lb (27—34 N · m). Check shaft end play using a dial indicating

micrometer. End play should be 0.003 to 0.005 inch. Remove clutch drum (13) and install sufficient number of shims (17), (18) and (19) to provide proper end play.

i. Press seal (16) into bore of housing (20), with sealing lip pointed toward bevel pinion (4). Install housing on hub (8).

j. Install drum (13) using screws (15) with correct number of shims (17), (18) and (19) in place. Tighten screws (15) to 20 to 25 ft-lb (27—34 N · m).

k. Install lock ring (14) with holes in the ring located directly in line with grease fittings (27). Warm bearing (12) and install the bearing firmly against lock ring (14).

l. Lubricate seal (11) with type GAA grease and install the seal in the bore of drum (13). Be sure seal seating surface is clean and free of burrs and nicks.

m. Install packing (10) on spacer (9) and slide the assembly into position on shaft (7).

5-47. Installation

Refer to paragraph 2-15 and install the horizontal swing shaft. Shims (25) and (26) and packing (24) are installed at this time.

Section IX. REPAIR OF SWING BRAKE SHAFT

5-48. Description

As is shown in figure 5-1, the swing brake shaft mates with the slewing ring, and is used to prevent the revolving frame from slewing or rotating uncontrolled.

5-49. Removal

The swing brake shaft cannot be removed as an assembly, but must be disassembled in place.

5-50. Disassembly

a. Refer to TM 5-3810-295-12 and perform the following procedure:

(1) Remove any front end attachment.

(2) Remove hook rollers.

(3) Drain oil from upper gear case, as shown in the lubrication chart.

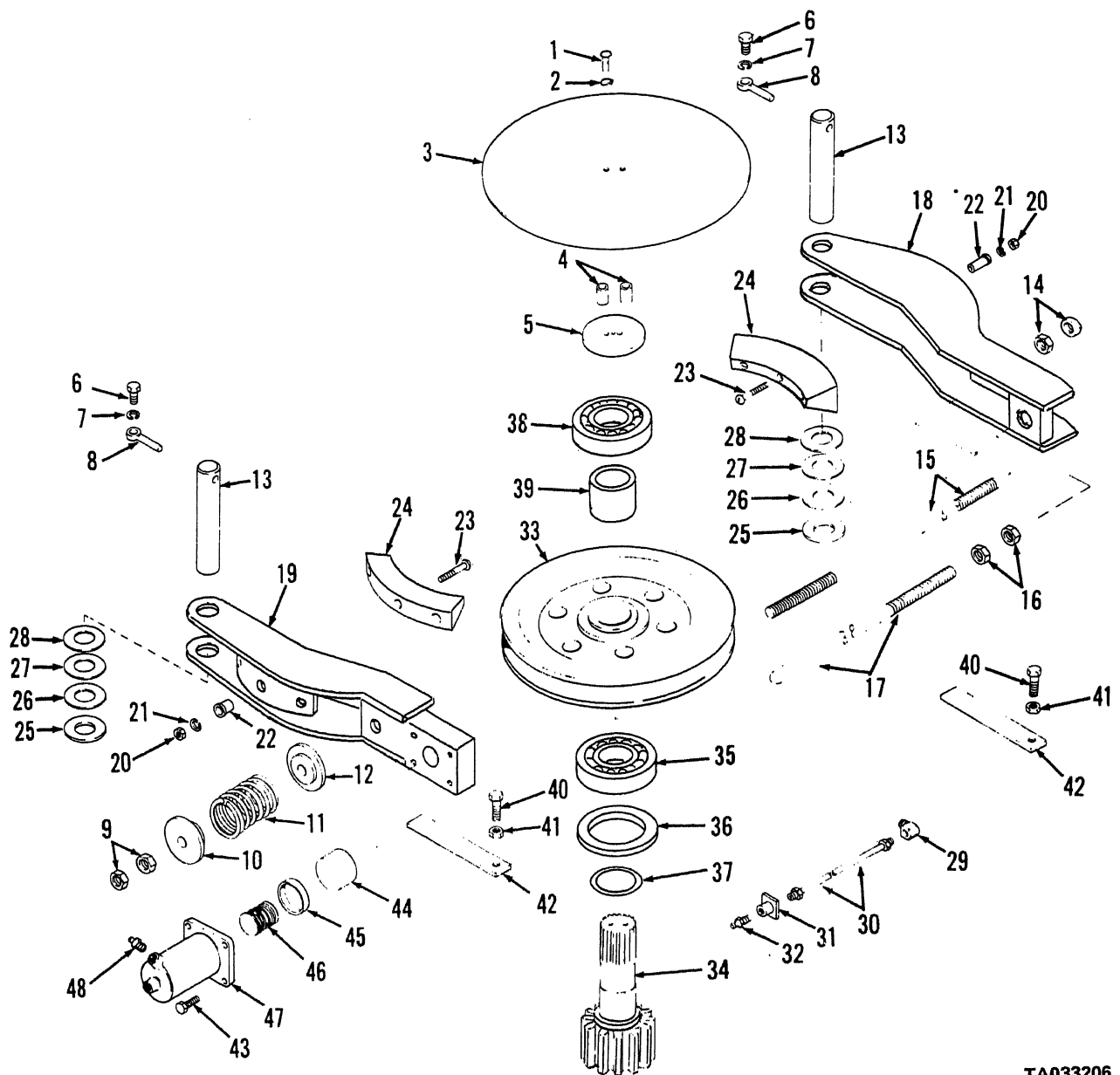
b. Using a suitable overhead crane, attach a lifting

slings to the bottom foot lugs on the revolving frame and to the gantry peak pin. Remove the upper from the carrier and place it on suitable blocking so that there is adequate working space beneath the revolving frame.

NOTE

Removing the revolving frame is only necessary if the swing brake shaft itself is to be removed. The wearing components of the brake, with the exceptions of the brake shaft and shaft bearings can be removed without undocking the machine.

c. Refer to figure 5-12 and remove the screws (1), lock washers (2), shield (3), pipe spacers (4), and retainer (5). Place blocking beneath shaft (34) to prevent it from falling.



TA033206

- 1 Cap screw (2)
- 2 Lock washer (2)
- 3 Shield
- 4 Pipe spacer (2)
- 5 Retainer
- 6 Cap screw (2)
- 7 Lock washer (2)
- 8 Eye bolt (2)
- 9 Nut (2)
- 10 Spring seat
- 11 Spring
- 12 Spring seat

- 13 Pin (2)
- 14 Nut (2)
- 15 Spring bolt
- 16 Nut (2)
- 17 Release rod
- 18 Brake shoe bracket
- 19 Brake shoe bracket
- 20 Nut
- 21 Lock washer
- 22 Bushing
- 23 Cap screw (6)
- 24 Brake lining (2)

- 25 Shim
- 26 Shim
- 27 Shim
- 28 Washer (2)
- 29 Male elbow
- 30 Tube assembly
- 31 Bracket
- 32 Grease fitting
- 33 Brake sheave
- 34 Brake shaft
- 35 Bearing
- 36 Retainer

- 37 Packing
- 38 Bearing
- 39 Spacer
- 40 Adjusting bolt (2)
- 41 Jam nut (2)
- 42 Bracket (2)
- 43 Capscrew (4)
- 44 Piston
- 45 Retainer
- 46 Spring
- 47 Cylinder
- 48 Bleeder fitting

Figure 5-12. Swing brake shaft assembly—exploded view.

d. Remove screws (6), lock washers (7) and eye bolts (8). Remove nuts (9), spring seat (10), spring (11), spring seat (12) and pins (13).

e. Remove nuts (14) and spring bolt (15), and loosen nuts (16) so that rod (17) can be unscrewed from brake shoe bracket (18).

f. Remove brake shoe brackets (19) and (18). Remove nuts (20), lock washers (21), bushings (22) and screws (23). Brake linings (24) can now be removed.

g. Remove shims (25), (26) and (27) and washer (28). Remove male elbow (29), tube assembly (30), bracket (31) and grease fitting (32).

h. Remove brake sheave (33) and press shaft (34) out of the bottom of the revolving frame. Bearing (35), retainer (36) and packing (37) come off with the shaft.

i. Remove bearing (38) and spacer (39) through the top of the bore in the revolving frame.

NOTE

Do not remove or change the adjustment of adjusting bolts (40), jam nuts (41) or brackets (42) unless one of these items must be replaced. These parts are used to maintain the brake shoes level.

j. Remove screws (43). The hydraulic cylinder (items 44 through 48) will then come off as an assembly. However, it is not recommended that these items be disassembled or disturbed unless replacement of parts is necessary.

5-51. Cleaning, Inspection and Repair

a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent, before inspecting.

b. Replace all seals, gaskets, deformed shims, packings, and other expendable parts.

c. Inspect all parts for wear, scoring, cracks, or any other signs of damage or excessive wear. Replace any parts not in good condition. Inspect gear teeth for severe wear, pitting and cracks, especially at the roots of the teeth.

d. Inspect and smooth all seal seating surfaces with a fine oil stone or crocus cloth.

5-52. Reassembly

a. Refer to figure 5-12 and install packing (37) in retainer (36). Place the assembled items on shaft (34) with the O-ring down.

b. Install bearing (35) on the shaft, with the bearing firmly against retainer (36). Install spacer (39) on the

shaft above bearing (35).

c. Assemble screws (23), spring bolt (15), nut (20), lock washer (21) and bushing (22) into brake shoe bracket (19). Assemble the identical items into brake shoe bracket (18).

d. Install piston (44), retainer (45), spring (46), cylinder (47) and bleeder fitting (48) on shoe bracket (19) and secure into position with screws (43).

e. Install release rod (17) with nuts (16) in place into bracket (18). Bracket (18) is tapped to receive the threaded end of the rod.

f. Insert bolt (15) into bracket (18) and secure with nuts (14). Place brake shoe bracket (19) over the opposite end of bolt (15).

g. Install spring seat (12), spring (11), spring seat (10) and nuts (9).

h. Install the preassembled shaft (34) into the bore of the revolving cylinder from beneath the frame. Install bearing (38) from above the frame.

i. Install sheave (33) and secure the sheave in place with retainer (5), spacers (4), shield (3), washers (2) and screws (1).

j. Place the two assembled brake shoe brackets (18) and (19) on sheave (33). Install washers (28) and shims (25), (26) and (27), and secure these with pins (13). Install screws (6), lock washers (7) and eye-bolts (8).

k. Install male elbow (29), tube assembly (30), bracket (31), and grease fitting (32).

5-53. Installation

a. Using an overhead crane or other suitable lifting device, attach lifting sling to the boom foot lugs on the revolving frame, and to the gantry peak pin. Install the revolving frame on the carrier, keeping the revolving frame stable in the lifting sling until the hook rollers are installed.

b. Refer to TM 5-3810-295-12, and perform the following procedure.

- (1) Install hook rollers.
- (2) Adjust swing brake.
- (3) Bleed hydraulic lines.
- (4) Lubricate swing brake shaft.

Section X. REPAIR OF VERTICAL SWING SHAFT

5-54. Description

The vertical swing shaft is driven from the horizontal swing shaft. The shaft terminates in a pinion which mates with the gear in the slewing ring, as shown in figure 5-1.

5-55. Removal

The vertical swing shaft cannot be moved as a major assembly, but must be disassembled in place.

5-56. Disassembly

a. Refer to TM 5-3810-295-12 and perform the following procedure.

- (1) Remove the boom assembly.
- (2) Remove hook rollers.
- (3) Drain main upper gear case oil.
- (4) Remove one horizontal swing shaft (left or right).

b. Deleted.

c. Attach a lifting sling to the boom foot lugs on the revolving frame and to the gantry peak pin. Using a suitable overhead crane or other lifting device, remove the upper from the carrier and place it on blocking such that there is ample working space beneath the revolving frame.

d. Refer to figure 5-13 and proceed as follows. Block the shaft from below so that it cannot fall. Then remove nuts (1), lock washers (2) and retainer (3).

e. From above, break lockwire (4), screws (5) and

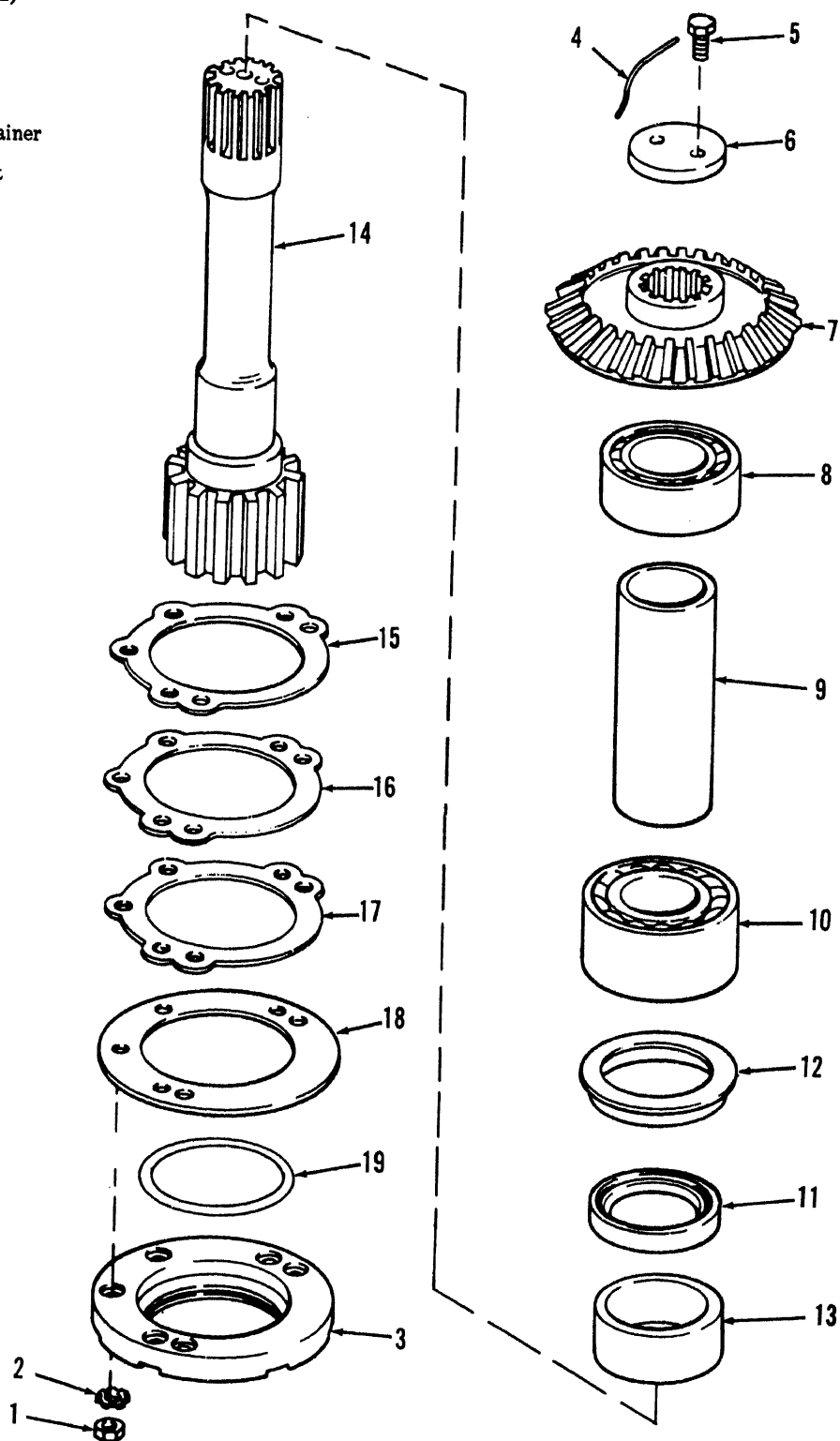
washers (6).

f. Carefully remove blocking beneath the shaft and lower the shaft through the bottom of the revolving frame. It may be necessary to bump the shaft from above to start it out of gear (7).

g. Remove bearing (8), spacer (9) and bearing (10) from the shaft. Remove oilseal (11), bearing retainer (12) and spacer (13). Shaft (14) has now been removed.

h. Set shims (15), (16) and (17) carefully to the side. Discard gasket (18) and packing (19).

- 1 Nut (6)
- 2 Lock washer (6)
- 3 Retainer
- 4 Lockwire
- 5 Cap screw (2)
- 6 Washer (2)
- 7 Gear
- 8 Bearing
- 9 Spacer
- 10 Bearing
- 11 Oil seal
- 12 Bearing retainer
- 13 Spacer
- 14 Pinion shaft
- 15 Shim
- 16 Shim
- 17 Shim
- 18 Gasket
- 19 Packing



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Figure 5-13. Vertical swing shaft assembly—exploded view.

5-57. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent, before inspecting.

b. Replace all gaskets, seals, deformed shims, packing, and other expendable parts.

c. Inspect all parts for wear, scoring, cracks or other signs of damage or excessive wear. Inspect gear teeth for signs of uneven wear, pitting or cracks, especially at the roots of the teeth.

d. Inspect and smooth all seal seating surfaces with a fine oil stone or crocus cloth.

5-58. Reassembly

a. Refer to figure 5-13 and install bearing (8). Install oil seal (11) in retainer (12), and spacer (13) with retainer (12) and oil seal (11) on pinion shaft (14).

b. Warm and install bearing (10) on pinion shaft (14), with the inner race of the bearing firmly against spacer (13).

c. Place spacer (9) on pinion shaft (14) and insert the entire assembly into position through the bottom of the bore. Temporarily hold the pinion shaft in place with blocking.

d. Install bearing (8), gear (7), washer (6) and screw (5) from the top of the assembly, working through the access opening in the revolving frame top. Do not lockwire the screws at this time.

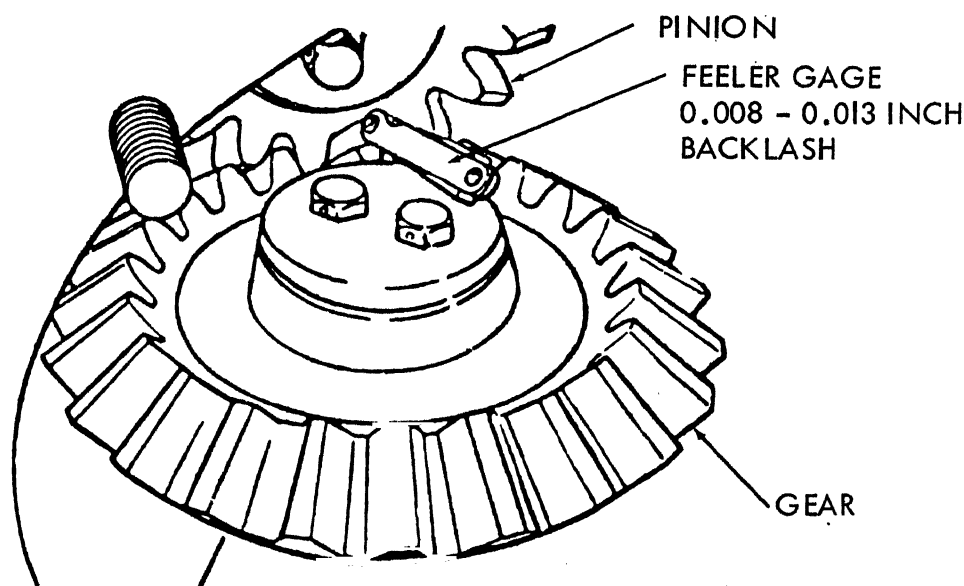
e. Install packing (19) in retainer (3), and install shims (15), (16) and (17), and gasket (18). Secure the entire assembly with nuts (1) and lock washers (2).

f. With the vertical swingshaft installed in this manner, check backlash and tooth contact between the horizontal swing shaft gears and the vertical swing shaft gear (7) as shown in figure 5-14.

g. Correct backlash is between 0.008 and 0.013 inch. If backlash is not within these limits, add or remove sufficient shims (15), (16) and (17) to bring backlash within these limits.

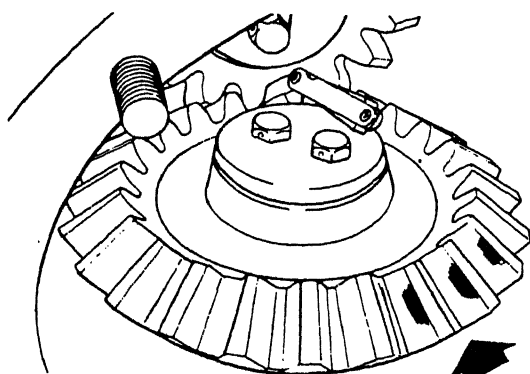
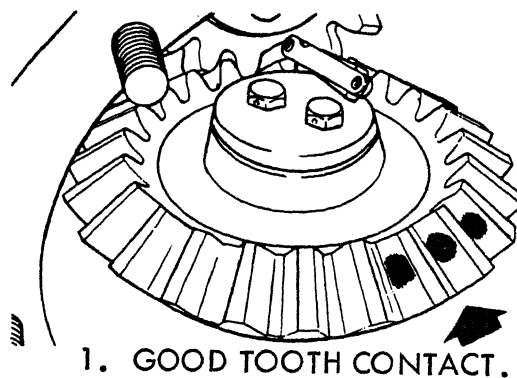
h. Gear tooth contact should be approximately in the center of vertical swing shaft gear (7) as illustrated in figure 5-15. If it is not in the approximate center, move the horizontal swing shaft in or out as required by removing or adding shims (25) and (26), figure 5-11.

i. After the above adjustments have been completed, lockwire screws (5), figure 5-13.

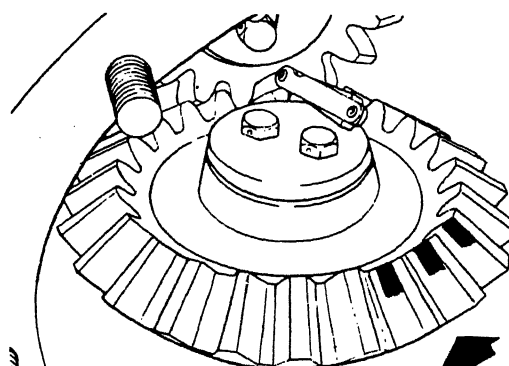


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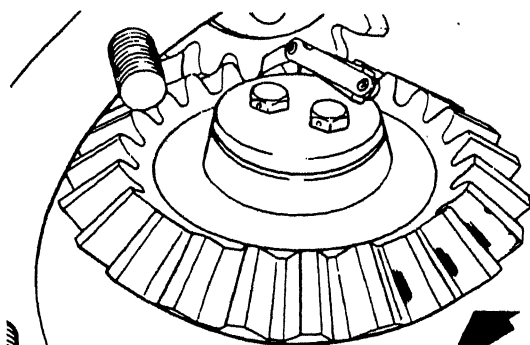
Figure 5-14. Checking vertical swingshaft bevel gear backlash.



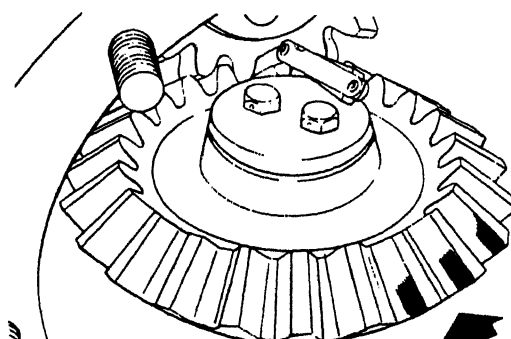
2. POOR - CAUSES TOOTH GALLING AND NOISY OPERATION. MOVE PINION TOWARD GEAR FOR CORRECT CONTACT AND LOWER GEAR FOR CORRECT BACKLASH.



3. POOR - CAUSES TOOTH GROOVING, GALLING AND NOISY OPERATION. MOVE PINION AWAY FROM GEAR FOR CORRECT CONTACT AND RAISE GEAR FOR CORRECT BACKLASH.



4. POOR - CAUSES CHIPPING AND EXCESSIVE WEAR. LOWER GEAR FOR CORRECT CONTACT, MOVE PINION TOWARD GEAR FOR CORRECT BACKLASH.



5. POOR - CAUSES CHIPPING AND EXCESSIVE WEAR. RAISE GEAR FOR CORRECT CONTACT, MOVE PINION AWAY FROM GEAR FOR CORRECT BACKLASH.

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Figure 5-15. Checking gear tooth contact.

5-59. Installation

a. Attach a lifting sling to the boom foot lugs on the revolving frame and to the gantry peak pin, and using an overhead crane position the revolving frame on the carrier. Keep the revolving frame stable in the lifting sling until the hook rollers are installed.

b. Refer to TM 5-3810-295-12 and perform the

following operations.

- (1) Install hook rollers.
- (2) Adjust horizontal swing shaft drive train tension.
- (3) Lubricate upper, including addition of oil to the gear case.

CHAPTER 6

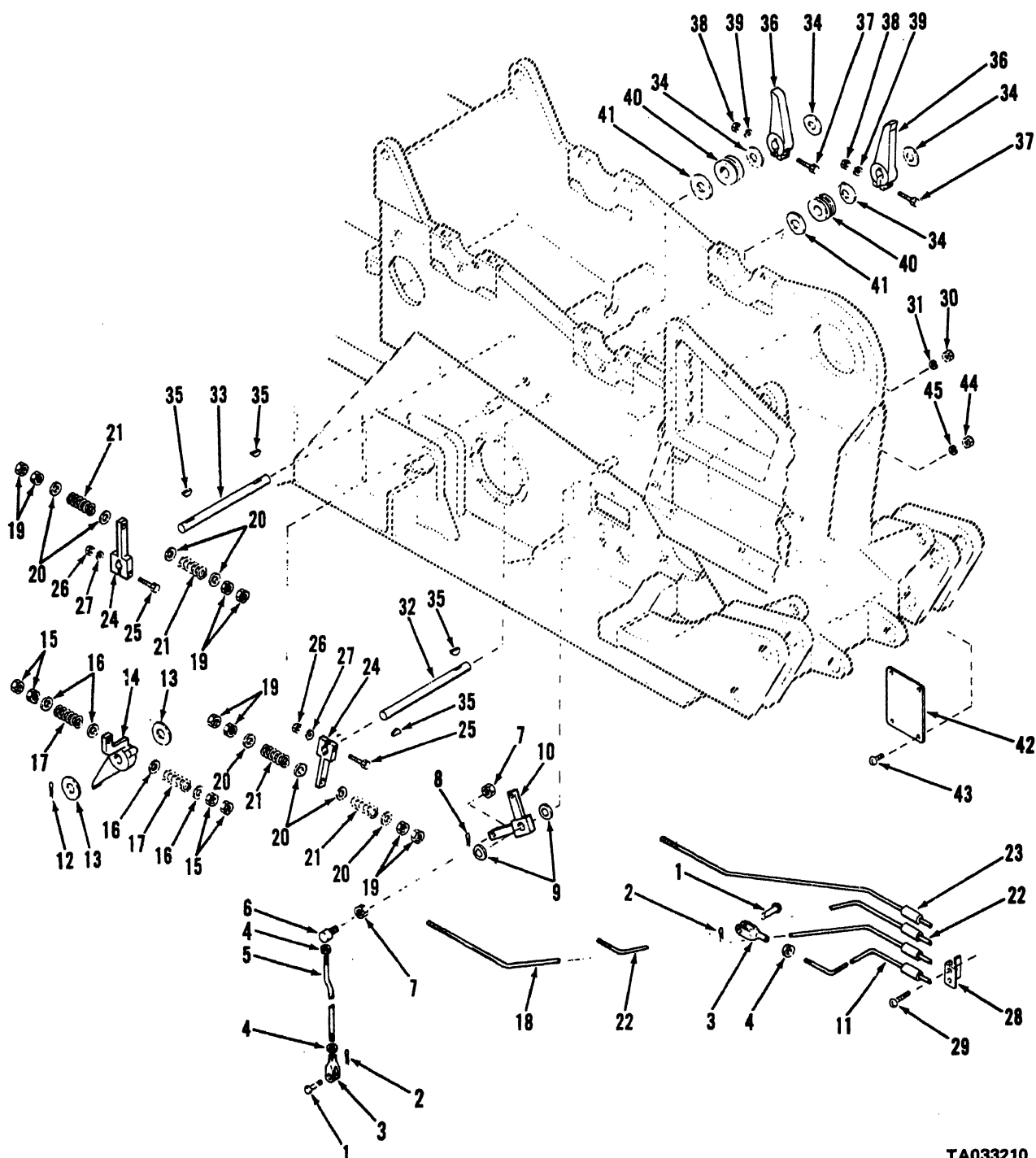
REPAIR OF THE CRANE LOCKS, BRAKES AND PAWLS

Section I. REPAIR OF PAWLS AND SWING LOCK LINKAGE

6-1. Description

Figure 6-1 illustrates the parts that make up the front and rear drum pawl linkage, and the connections to the swing lock assembly. When engaged by the operator the pawls will prevent the respective drumshafts from

turning. The swing lock, when engaged, will prevent the crane (revolving frame) from turning on the carrier. Refer to TM 5-3810-295-12 for repair data for the boom hoist pawl and linkage (item 12—18, fig. 6-1).



TA033210

- 1 Pin
- 2 Cotter pin
- 3 Yoke (2)
- 4 Nut (2)
- 5 Control rod
- 6 Ball joint
- 7 Nut (3)
- 8 Cotter pin
- 9 Washer (2)
- 10 Lever
- 11 Control rod
- 12 Cotter pin

- 13 Washer (2)
- 14 Drum pawl
- 15 Nut (4)
- 16 Washer (4)
- 17 Spring (2)
- 18 Control rod
- 19 Nut (8)
- 20 Washer (8)
- 21 Spring (4)
- 22 Control rod
- 23 Control rod

- 24 Lever
- 25 Cap screw (2)
- 26 Nut (2)
- 27 Lock washer (2)
- 28 Guide (3)
- 29 Screw (6)
- 30 Nut (6)
- 31 Lock washer (6)
- 32 Shaft
- 33 Shaft
- 34 Washer (4)

- 35 Key (4)
- 36 Pawl (2)
- 37 Cap screw (2)
- 38 Nut (2)
- 39 Lock washer (2)
- 40 Grommet (2)
- 41 Weldcap (2)
- 42 Instruction plate
- 43 Screw (4)
- 44 Nut (4)
- 45 Lock washer (4)

Figure 6-1. Pawls and swing lock assembly linkage.

6-2. Repair and Replacement

Repair of the pawls and swing lock are limited to straightening bends in the linkage and/or replacement of any other defective or damaged parts.

6-3. Adjustment

Adjust pawl and swing lock linkages as described in TM 5-3810-295-12.

Section II. REPAIR OF SWING LOCK

6-4. Description

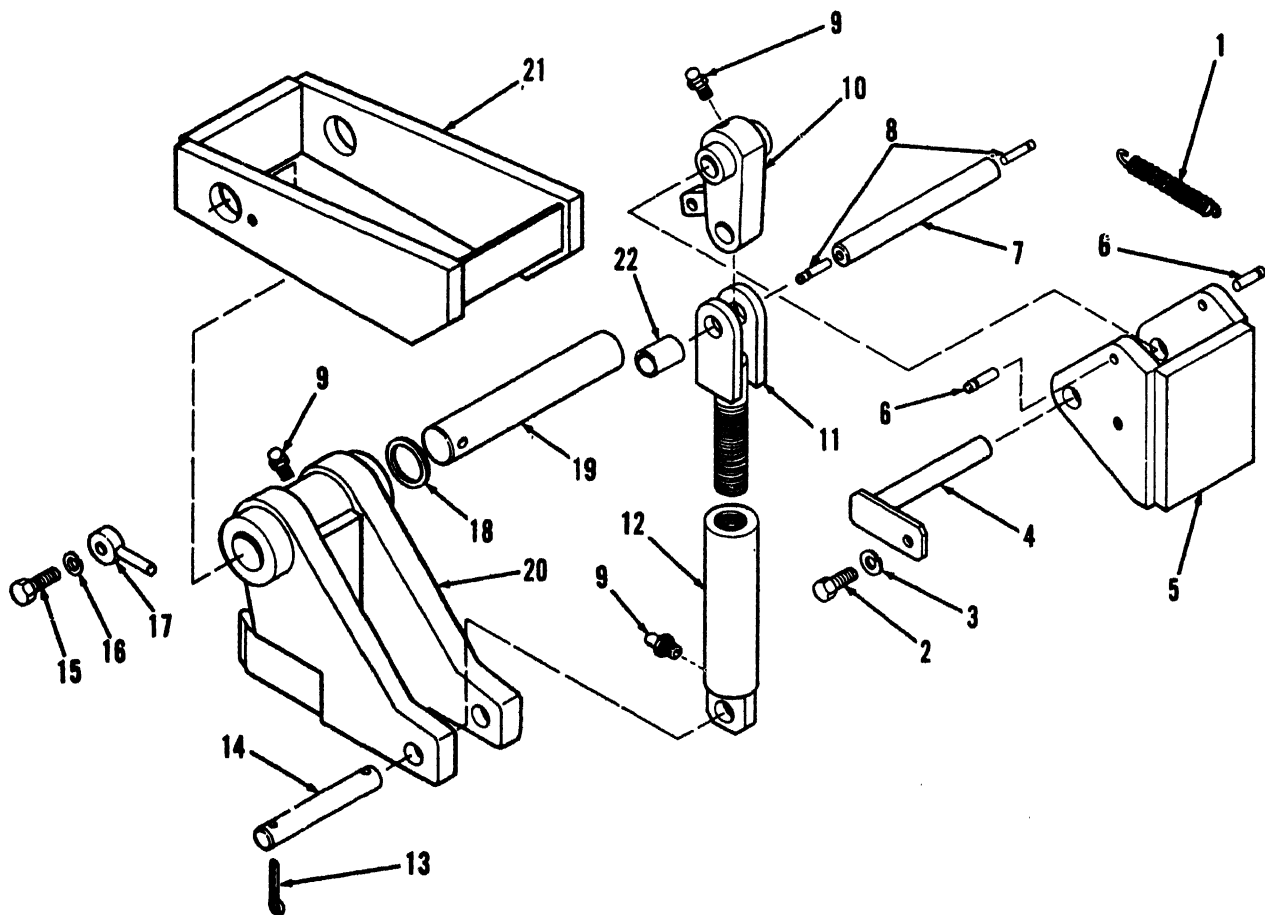
Once engaged, the swing lock will prevent the crane (revolving frame) from revolving on the carrier.

6-5. Removal and Disassembly

NOTE

Brackets (5) and (21) are welded to frame and are shown for reference only.

Remove swing lock assembly by referring to figure 6-2 and disassembling in accordance with order of index numbers.



TA033211

- 1 Spring (2)
- 2 Cap screw
- 3 Lock washer
- 4 Pin
- 5 Bracket
- 6 Pin (2)
- 7 Pin
- 8 Pin (2)

- 9 Lubrication fitting (3)
- 10 Lever
- 11 Yoke rod
- 12 Eye bolt
- 13 Cotter pin (2)
- 14 Pin
- 15 Cap screw

- 16 Lock washer
- 17 Rod end
- 18 Shim (8)
- 19 Pin
- 20 Dog
- 21 Bracket
- 22 Pipe (2)

Figure 6-2. Swing lock assembly—exploded view.

6-6. Cleaning, Inspection and Repair

- a. Clean the swing lock assembly with a wire brush or suitable cleaning solvent.
- b. Inspect screws, rod end and yoke end threads for damage or cross threads. Inspect pins and mating bores for excessive wear, scoring or other damage.

c. Repair the swing lock assembly by replacing any defective parts and adjust in accordance with instructions contained in TM 5-3810-295-12.

6-7. Reassembly

Refer to figure 6-2 and reassemble the swing lock as shown.

Section III. REPAIR OF CRANE LOCK

6-8. Description

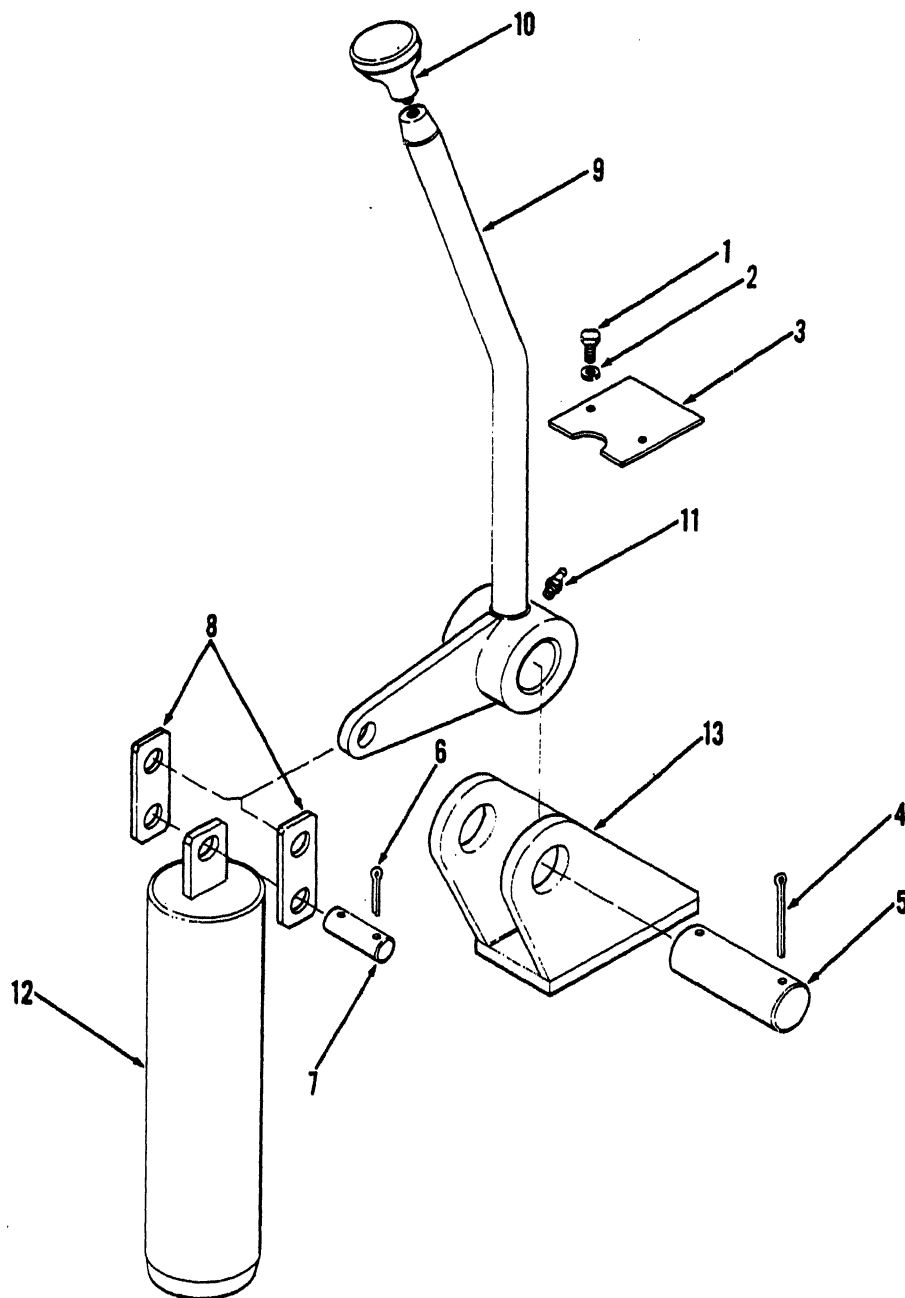
The crane lock, once engaged, will prevent the crane from revolving on the carrier.

6-9. Removal and Disassembly

Refer to figure 6-3, and remove and disassemble the crane lock assembly as required for replacement of defective parts.

6-10. Cleaning, Inspection and Repair

- a. Clean all parts in an approved cleaning solvent such as Federal Specification P-D-680.
- b. Inspect all parts for cracks, excessive wear or other damage. Inspect lubrication fitting (11) for obstructed part.



TA033212

- 1 Cap screw (2)
- 2 Lock washer (2)
- 3 Lock plate
- 4 Cotter pin (2)
- 5 Pin
- 6 Cotter pin (4)
- 7 Pin (2)

- 8 Sink (2)
- 9 Lever
- 10 Knob
- 11 Lubrication fitting
- 12 Pin
- 13 Bracket

Figure 6-3. Crane lock assembly.

c. Repair the crane lock by replacing any parts that are defective.

6-11. Reassembly and Installation

Refer to figure 6-3 and reassemble the crane lock as re-

quired. Install and lubricate the crane lock assembly. Lock plate (3) is used to lock the lever in the disengaged position only.

CHAPTER 7

REPAIR OF CRANE CAB COMPONENTS AND CONTROLS

Section I. REPAIR OF SWING BRAKE CONTROL STAND

7-1. Description

The swing brake control stand provides a housing for the swing brake control lever. The swing brake control lever is designed so that the swing brake is always applied unless the lever is released by the operator.

7-2. Removal

- a. Disconnect hydraulic fluid lines and drain master cylinder or fluid.
- b. Immediately plug hydraulic lines.

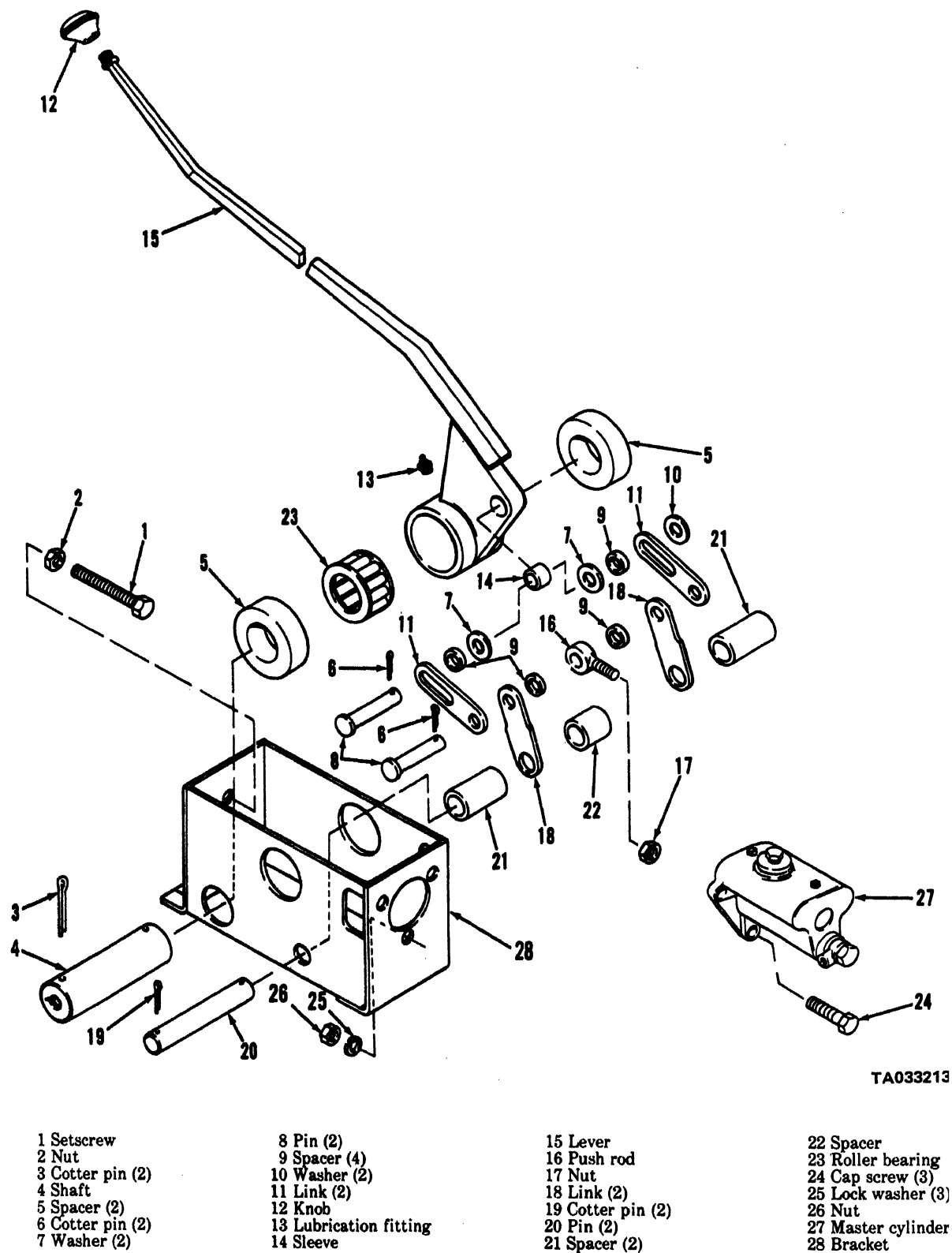
7-3. Disassembly

Refer to figure 7-1 and disassemble the swing brake

control stand as indicated by the order of index numbers.

7-4. Cleaning, Inspection and Repair

- a. Clean all parts of the swing control stand with cleaning solvent, Federal Specification P-D-680, and wipe dry.
- b. Inspect pins, links and spacers for excessive wear or damage. Inspect threads on screws and yoke end for damage.
- c. Repair the control stand by replacing any damaged or excessively worn parts.



TA033213

Figure 7-1. Swing brake control stand assembly—exploded view.

5. Reassembly

Refer to figure 7-1 and reassemble the control stand in

the reverse order of disassembly.

Section II. REPAIR OF MASTER CYLINDER

7-6. Description

a. The master cylinder assembly consists of a reservoir and cylinder assembly. Between the cylinder and reservoir there is an intake port and a bypass (compensating) port. Unless actuated, the cylinder is in the neutral (bypass) position and will allow for temperature expansion or contraction or seepage in the closed hydraulic system.

b. When the cylinder is engaged, the piston movement seals off the bypass port and forces fluid into the line. The fluid movement builds pressure in the line and will actuate the hydraulic cylinder at the appropriate brake or clutch.

7-7. Removal

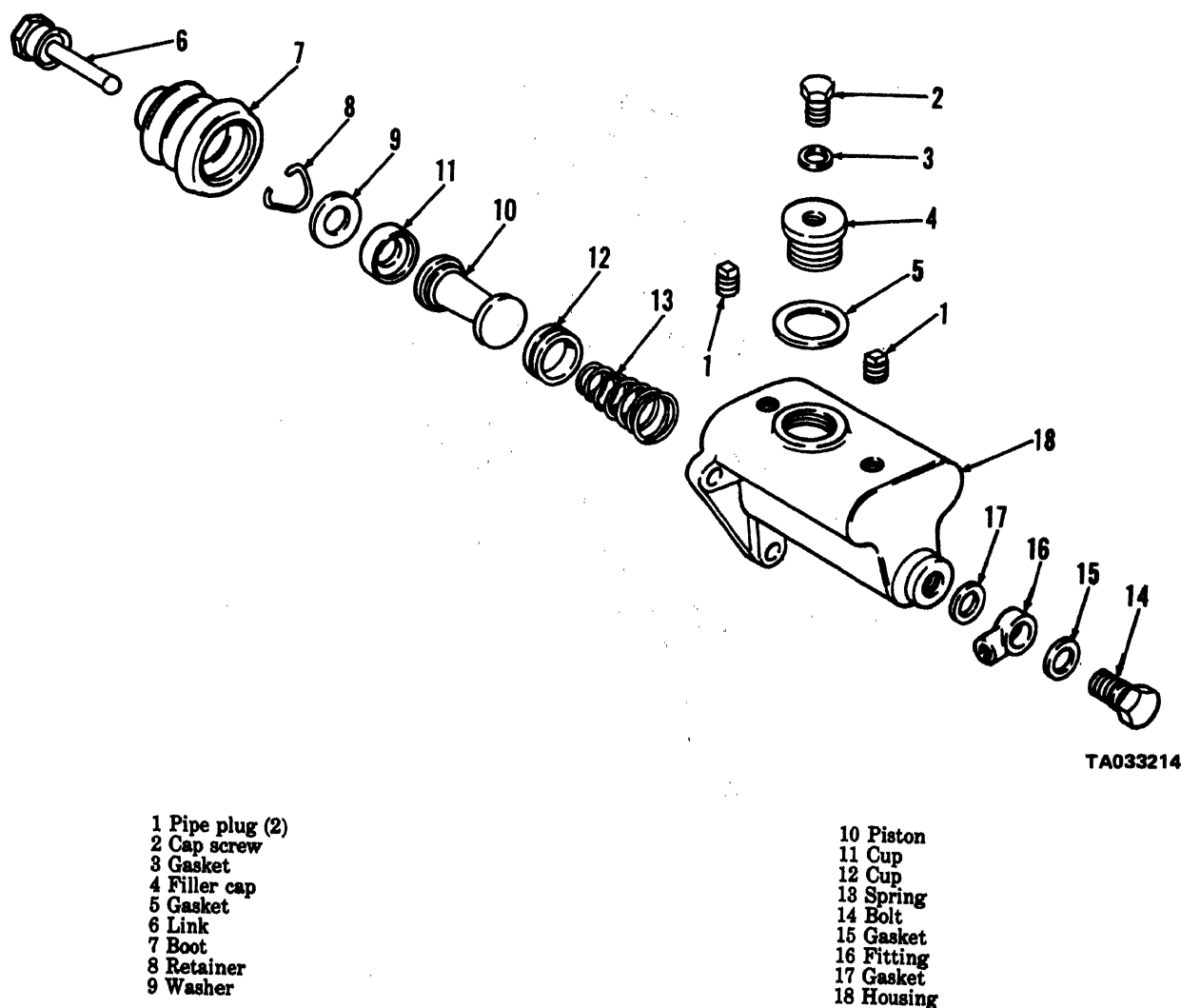
Refer to paragraphs 7-2 and 7-3 for removal instructions of the master cylinder.

7-8. Disassembly

a. Refer to figure 7-2. Remove two plugs (1). Remove screw (2), gasket (3), filler cap (4) and gasket (5).

b. Remove link (6) and boot (7). Remove retainer (8) and slide washer (9), cups (11) and (12), piston (10) and spring (13) out of housing (18).

c. Remove bolt (14), gaskets (15) and (17), and fitting (16).



TA033214

Figure 7-2. Master cylinder assembly—exploded view.

7-9. Cleaning, Inspection and Repair

a. Clean housing and all other metal parts with suitable cleaning solvent, such as Federal Specification P-D-680 or equivalent. Immediately after cleaning,

immerse parts in hydraulic fluid (same type used in system) to remove all traces of cleaning solvent. Dry parts with compressed air or a clean, dry, lint-free cloth after cleaning.

b. Hold the housing toward a strong light source and inspect the cylinder bore for pitting, scratches and visible wear pattern. If any of these defects are present, replace entire assembly.

c. Using a hone, remove any dirt not removed during the cleaning process. A hone may be used to clean the cylinder bore if done with extreme care.

(1) Using an inside micrometer compare the bore diameter of the cylinder to a new assembly. The difference between the two should be no greater than 0.007 inch.

(2) An alternate method is to install the piston (10, fig. 7-2) into the housing (18) and check clearance using a wire feeler gage. If clearance exceeds 0.007 inch replace entire assembly.

CAUTION

Insure that no burrs remain if a housing has been honed. Remove any burrs with a deburring tool if necessary. If burrs are not removed, damage to the cylinder cups (11 & 12, fig. 7-2) and fluid leakage will result.

d. Insure that intake and bypass ports (located between housing bore and housing reservoir) are clean and free of restrictions. Use a soft copper wire not larger than 0.020-inch diameter to probe and clean

ports.

e. Inspect spring for cracks or permanent set and replace if damaged.

f. Always replace cups (11 & 12) if piston (10) has been removed.

g. Inspect threads on screws, fittings and filler cap. Replace if damaged.

7-10. Reassembly

a. Lubricate all parts with hydraulic fluid.

b. Replace gaskets (15 and 17, fig. 7-2) and install fitting (16) and screw (14).

c. Install spring (13) into housing (18). Position new cups (11 and 12) on piston (10) and install piston. Install washer (9) and retainer (8).

d. Place boot (7) over end of housing (18) and install link (6).

e. Install gasket (5), filler cap (4), gasket (3) and screw (2). Install pipe plugs (1).

f. If the master cylinder assembly is not to be installed immediately wrap in preservative paper for storage.

7-11. Installation

Refer to TM 5-3810-295-12 for installation procedures.

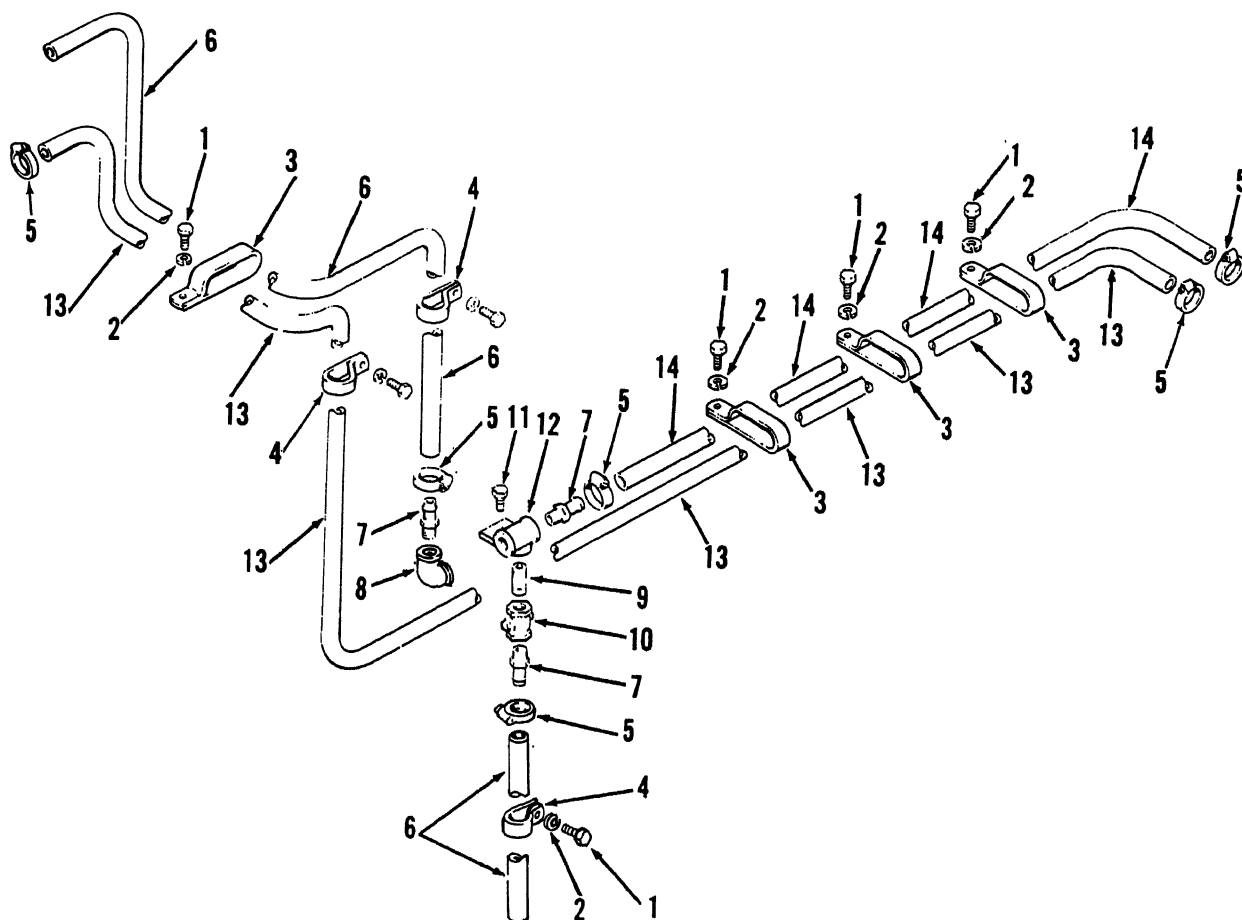
Section III. REPAIR OF CRANE HEATER AND LINES

7-12. Removal and Disassembly

a. Disconnect the electrical lead.

b. Drain the heater of engine coolant at drain valve (10, fig. 7-3).

c. Refer to figure 7-3 and remove lines, clamps and attaching parts as required. Refer to figure 7-4 and remove components of the heater assembly as required for repair or replacement.

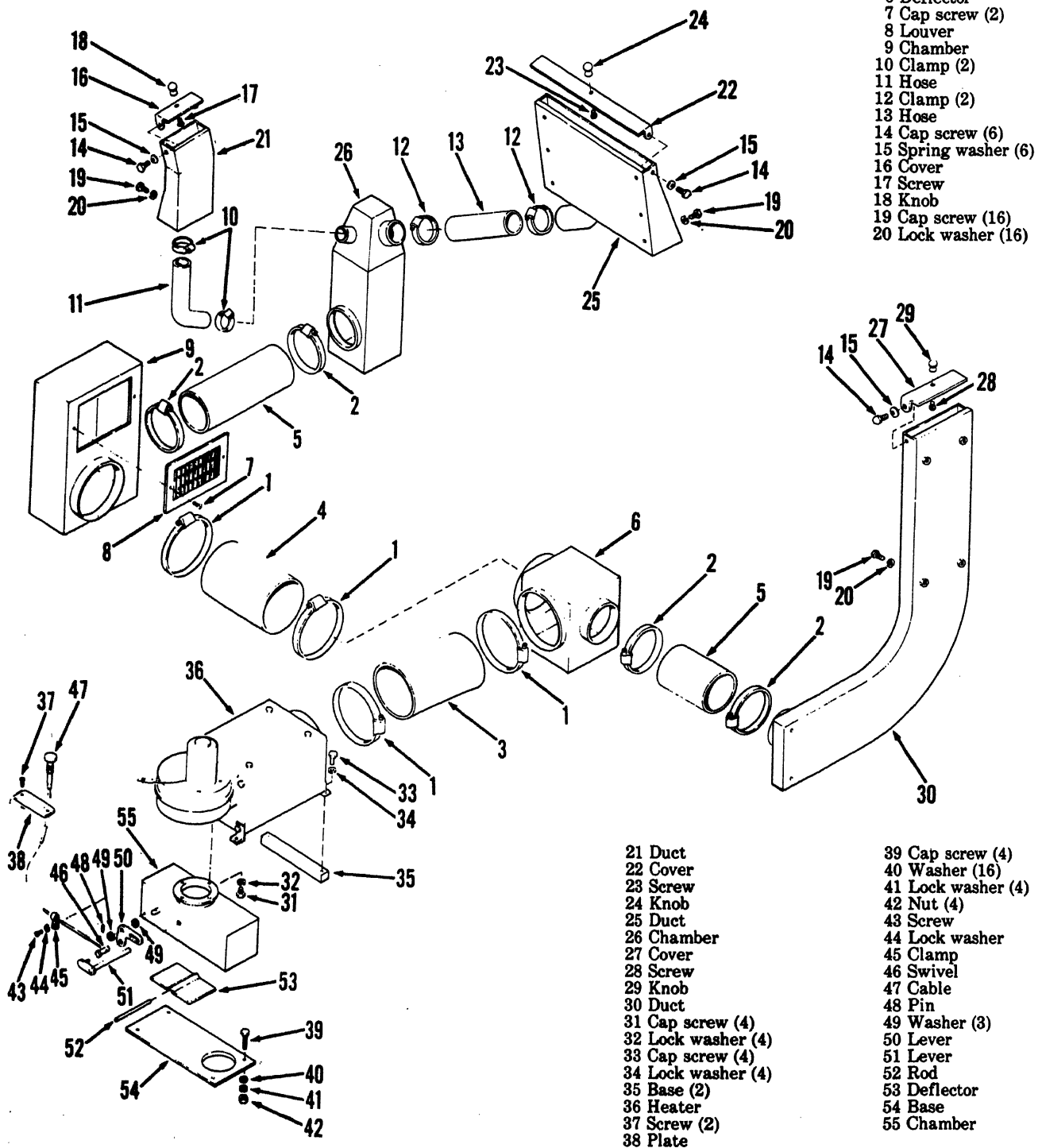


TA033215

- 1 Cap screw (8)
- 2 Lock washer (8)
- 3 Clamp (5)
- 4 Clamp (2)
- 5 Clamp (2)
- 6 Hose
- 7 Fitting (3)
- 8 Elbow
- 9 Nipple (2)
- 10 Drain valve
- 11 Cap screw (2)
- 12 Tee
- 13 Hose
- 14 Hose

Figure 7-3. Heater lines and drain valve.

- 1 Clamp (4)
- 2 Clamp (4)
- 3 Duct
- 4 Duct
- 5 Duct (2)
- 6 Deflector
- 7 Cap screw (2)
- 8 Louver
- 9 Chamber
- 10 Clamp (2)
- 11 Hose
- 12 Clamp (2)
- 13 Hose
- 14 Cap screw (6)
- 15 Spring washer (6)
- 16 Cover
- 17 Screw
- 18 Knob
- 19 Cap screw (16)
- 20 Lock washer (16)



- 21 Duct
- 22 Cover
- 23 Screw
- 24 Knob
- 25 Duct
- 26 Chamber
- 27 Cover
- 28 Screw
- 29 Knob
- 30 Duct
- 31 Cap screw (4)
- 32 Lock washer (4)
- 33 Cap screw (4)
- 34 Lock washer (4)
- 35 Base (2)
- 36 Heater
- 37 Screw (2)
- 38 Plate

- 39 Cap screw (4)
- 40 Washer (16)
- 41 Lock washer (4)
- 42 Nut (4)
- 43 Screw
- 44 Lock washer
- 45 Clamp
- 46 Swivel
- 47 Cable
- 48 Pin
- 49 Washer (3)
- 50 Lever
- 51 Lever
- 52 Rod
- 53 Deflector
- 54 Base
- 55 Chamber

TA033216

Figure 7-4. Heater assembly—exploded view.

7-13. Cleaning, Inspection and Repair

NOTE

Do not immerse heater in cleaning solvent.

- a. Unclog air ducts and chambers. Clean parts and dry thoroughly.
- b. Inspect heater for damage. Inspect air ducts and hoses for cracks, breaks or other damage.
- c. Straighten dents and bends on air ducts. Minor

breaks or cracks in hoses or duct may be patched with heavy-duty fabric tape.

7-14. Reassembly and Installation

- a. Refer to figure 7-3 and 7-4 and reassemble the heater lines and heater assembly.
- b. Refer to TM 5-3810-295-12 to install, service and reconnect the heater assembly.

CHAPTER 8 REPAIR OF SAFETY DEVICES

Section I. REPAIR OF LOAD SAFETY COMPUTER WARNING DEVICE ASSEMBLY

8-1. Description

a. The load moment safety warning assembly (trade name "Lode-Safe-T-Computer" (LSTC)) is designed to warn the operator when the angle of the boom or load or a combination of both reach an unsafe limit. The warning assembly consists basically of a computer console, a remote indicator, a selector switch, a boom angle indicator, load cells, a warning bell and connecting cables.

b. The components of the warning device function as follows: (see fig. 8-1)

(1) The load cell assembly is located in the boom suspension line. The cell measures the tension in the line caused by the load. The tension is converted into an electrical signal and transmitted to the load computer console.

(2) The boom angle transducer is mounted on the lower end of the boom base section. The transducer will determine the angle of the boom with respect to ground level. This measurement will also be converted into an electrical signal and transmitted to the load computer.

(3) A program card selected by the crane operator for a particular type of operation (see TM 5-3810-295-12) is placed into the load computer. The program cards are wired for different types of operation i.e. tires and floats and stored in the crane cab.

(4) The load computer, based on the information it receives from the load cell, angle transducer, and program card, will send signals to the visual remote indicator and bell when the unsafe load has been approached (90 percent) or reached.

(5) The correct program card must be inserted into the load computer to give an accurate reading for a

given operation. Refer to TM 5-3810-295-12 for more information concerning program cards.

c. The load moment safety device (Figure 8-1) is required for all dockside, ship loading/unloading operations.

(1) If your load moment safety device fails, and your crane is used to perform dockside, ship loading/unloading operations, follow authorized troubleshooting procedures. If the malfunction is not corrected by troubleshooting, remove the entire assembly (Figure 8-1), including all units and connecting wiring, and return it to the factory for repair and recalibration as a complete unit.

(2) Missions other than dockside, ship loading/unloading operations may be performed using only the load chart located in the upper crane cab and the mechanical boom angle indicator located on the lower crane boom. If your load moment safety device fails, and your crane is not used to perform dockside, ship loading/unloading operations, follow one of these options:

(a) Remove the device and turn it in to your PDO.

(b) Troubleshoot and repair using the procedure outlined in para (1) above.

8-2. Removal

WARNING

Prior to performing work on load moment safety device, disconnect battery to prevent electrical shock.

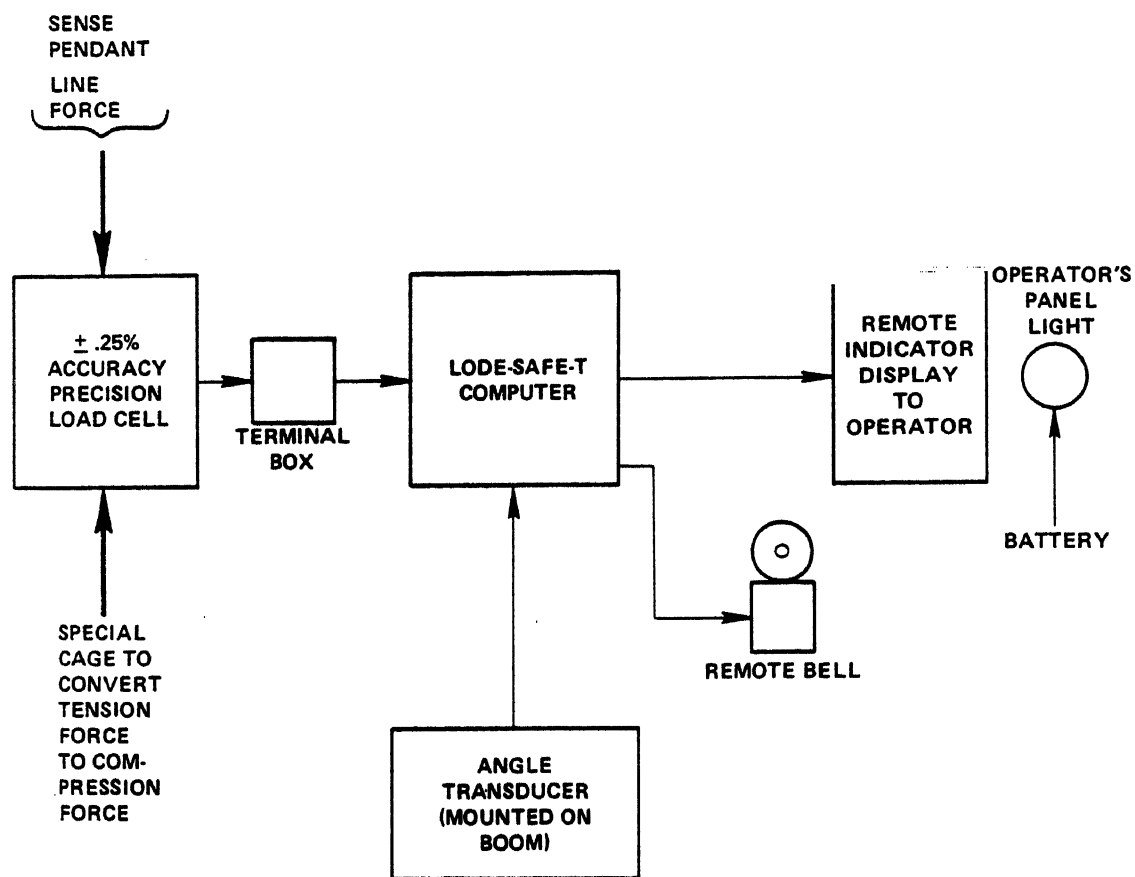
NOTE

Prior to removing wires and cables insure they are tagged and identified to aid in re-installation.

a. Refer to figure 8-2 and remove wiring as required per paragraph 8-5.

b. Remove the load moment safety components as required after performing testing per paragraph 8-5.

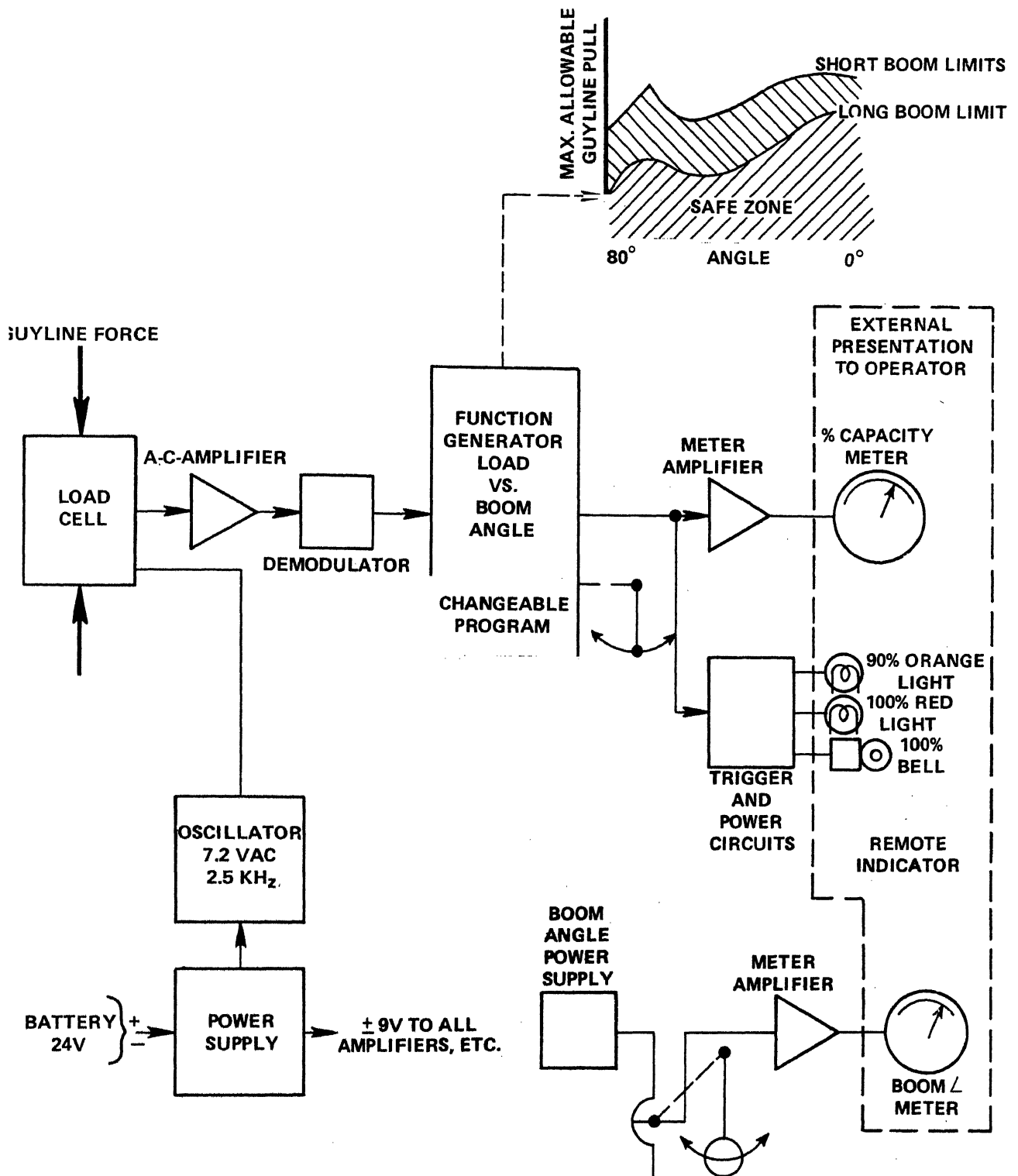
LODE-SAFE-T COMPUTER
PHYSICAL UNITS



AUTOMATIC WARNING SYSTEM

TA033217

Figure 8-1. Load moment safety device.



**AUTOMATIC WARNING SYSTEM
COMPUTER FUNCTIONAL BLOCK DIAGRAM
LODE-SAFE-T COMPUTER**

TA033218

Figure 8-2. Safety device block and wiring diagram (sheet 1 of 2).

TA033219

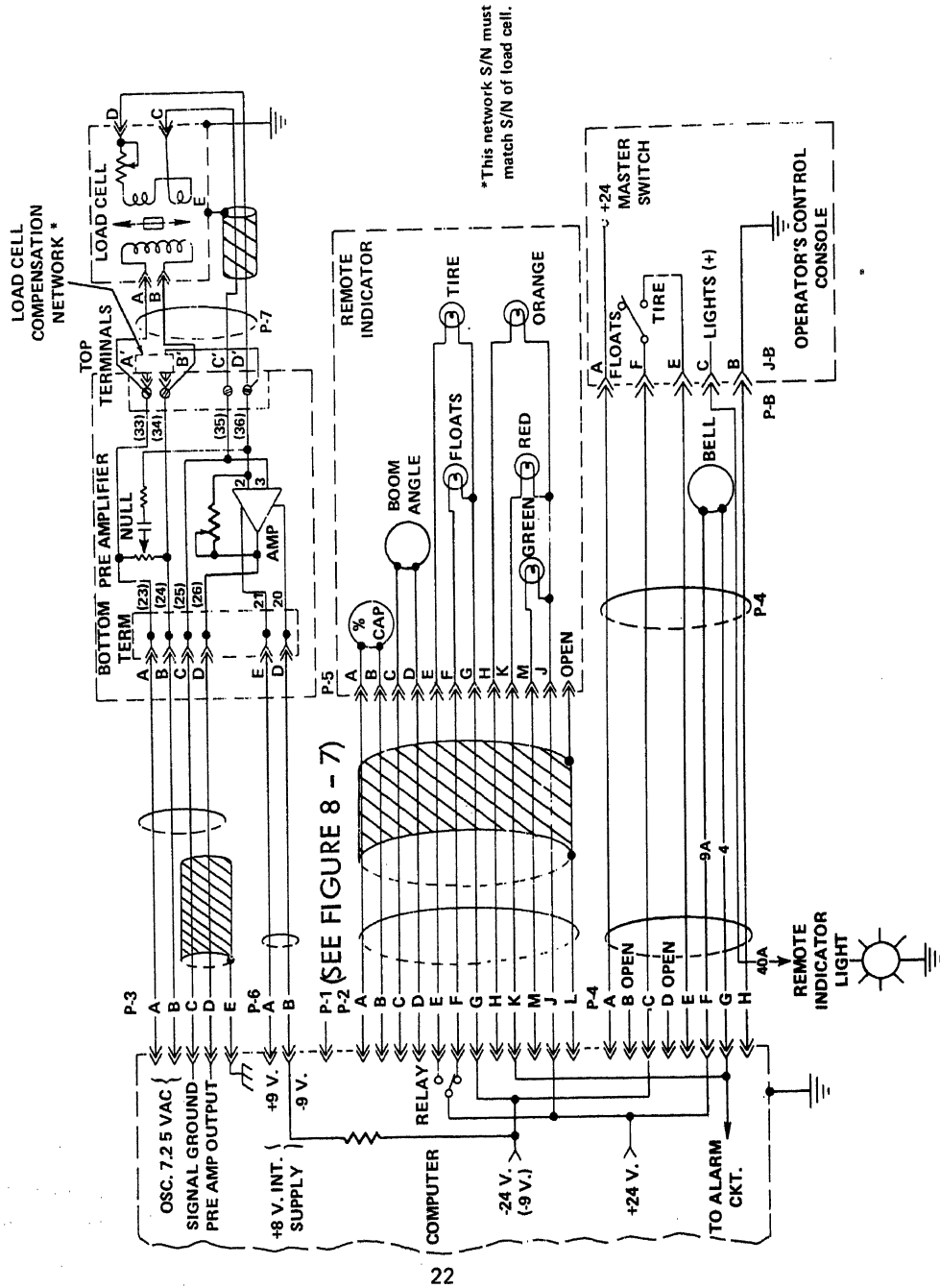


Figure 8-2. Safety device block and wiring diagram (sheet 2 of 2).

8-3. Cleaning, Inspection and Repair

a. Cleaning is limited to the removal of corrosion from terminals and lugs and removing dirt from external component cases. Clean program cards with an approved cleaning solvent and buff terminal with a pencil eraser.

b. Inspect the wiring for loose connections, corroded terminals and damaged components.

c. Repair is limited to replacement of major assemblies of the load moment safety computer as described in paragraph 8-5a.

8-4. Reassembly and Installation

NOTE

Angle transducer axis must be parallel to boom axis on installation.

a. Install and connect wiring as shown in figure 8-1.

b. Check to be sure all connections are correct and

are securely attached.

8-5. Testing

a. *LSTC Test Procedure.* Before making detailed tests tabulated below on the Load Moment Safety Computer, make operator's test consisting of physical inspection and operation check. This is recommended to eliminate the problems which are most likely to occur. A complete system checkout is listed in table 8-1 and is to be followed in sequence. If a specific criteria is not met, refer to corrective action as detailed in paragraph 8-5b.

CAUTION

Use great care in making voltage readings to prevent damage to LSTC components by shorting or grounding of test leads or contacts.

Table 8-1. Test Procedure

Step	Test	Procedure	Corrective action
1	Power-In	Remove all cables from end of LSTC Console. With Master switch turned "ON". Measure with voltmeter input voltage on P4 cable (79R375); pins "A" to "H". Proper voltage will be between 24.0VDC to 32.0VDC.	1
2	Bell	Measure with ohmmeter from P4-F to P4-G on cable to assure connection. Approximate ohm load of bell should be 36 ohms (+3 ohms).	2
3	"Floats/tires" switch	Measure with ohmmeter from P4-C to P4-E on cable to be open when floats/tires—s in "Floats" position and closed in "Tires".	3
4	LSTC fuse	Connect Cable P4 to LSTC Console. Turn LSTC Control Switch to "RUN". Two fuses on front panel are good if knobs are not lighted. This then puts power into the computer for further checks.	4
5	LSTC power	Measure with a D.C. Voltmeter from pin P2-G to P2-J on LSTC Console. Pin "J" is positive. Voltage will be (battery voltage minus approx. 1.7V) 22.3 to 30.3 VDC. Record.	5
6	Regulated supply	Measure with D.C. Voltmeter from Pin P6-A to P6-B on LSTC Console. "A" will be positive. Voltage should be approximately between 19.1V & 18.3V.	5
7	Pos. 9V bus	Measure with D.C. Voltmeter from Pin P6-A to P6-C on LSTC Console. "A" will be positive. Voltage should be 1/2 of voltage step 6 or between +9.550VDC & +9.150VDC. Record value.	5
8	Neg. 9V bus	Measure with D.C. Voltmeter from Pin P6-B to P6-C on LSTC Console. "B" will be negative. Voltage should be 1/2 of voltage in step 6 or between -9.550VDC or -9.150 VDC. Record value.	5
9	Balanced Buses	Subtract & compare. Recorded values of Steps 7 & 8 must be within .040VDC of each other.	5
10	Load cell power oscillator voltage	Measure with A.C. Voltmeter from Pin P3-A to P3-B. No load voltage will be 7.250 ± .02VAC.	5
11	Oscillator frequency	Measure frequency using scope to verify the frequency to be between 2400 hz and 2570 hz. (416.6 micro-sec. to 389.1 micro-sec.)	5
12	Shield connection	Load Cell Cable Shield is terminated at LSTC Console. Verify connection by using ohmmeter to check continuity from Pin P3-E to LSTC Console cabinet. (Using ohmmeter also check for continuity from LSTC Console to machine frame. Ground Console if necessary.)	5
13	Boom angle power	Measure using D.C. Voltmeter from Pin P1-A to P1-B on LSTC Console. No load voltage will be 6.4VDC ± .1VDC. Pin "B" will be positive.	5
14	"Floats" light power	Place "Floats/Tires" Switch in "Floats" Position. Measure using D.C. Voltmeter from Pin P2-F to P2-G. Pin "F" will be positive. Compare Voltage to voltage recorded in Step 5; should be within ± 0.5V.	5
15	"Tires" light power	Place "Floats/Tires" Switch in "Tires" Position. Measure using D.C. Voltmeter from Pin P2-E to P2-6. Pin "E" will be positive.	5
16	Remote indicator cable	Test Cable P2-P5 (79T170) per Cable Test Instructions.	6
17	Remote indicator	Measure resistance using an ohmmeter at connector P5 on Remote Indicator as follows: P5-A to P5-B approx. 445-455 ohms.	7

Table 8-1. Test Procedure—Continued

Step	Test	Procedure	Corrective action
		" C to " D approx. 445-455 ohms.	7
		" E to " G approx. 30-45 ohms.	8
		" F to " G approx. 30-45 ohms.	8
		" H to " J approx. 30-45 ohms.	8
		" K to " J approx. 30-45 ohms.	8
		" M to " J approx. 30-45 ohms.	8
		Using 100K scale on ohmmeter check pin to Remote Indicator Cabinet should read Infinity.	1
18	Remote indicator warning lights	Install Remote Indicator Cable P2-P5 to P5 at Remote Indicator <i>only</i> . 1. Connect Jumper from Computer P2-J to Cable pin "J". 2. Connect Jumper from Computer P2-G to Cable pin "K". Observe red light, move P2-G Jumper to Pin "H" and Pin "M" observe, orange & green respectively. Remove both jumpers.	8, 5 8, 5
19	Remote indicator "floats/tires" lights	1. Connect Jumper from Computer P2-G to Cable Pin G. 2. Connect Jumper from Computer P2-J to Cable Pin "F" and "E" observe blue lights for "Floats" & "Tires" respectively.	8, 5
20	Angle transducer	Check Angle Transducer: Unlock transducer and position pendulum somewhere in midrange of its travel. (DO NOT hold in this position by using transducer lock, but tape or prop with a small wooden block into this position.) Using 100K scale on ohmmeter check as follows for continuity & leakage: 1. <i>Continuity—Desirable</i> A to B E to R J to R N to R A to C F to R K to R P to R B to C G to R L to R M to S D to R H to R M to R T to Case 2. <i>Leakage—Undesirable</i> A to T F to T L to T B to T G to T M to T C to T H to T N to T D to T J to T P to T E to T K to T R to T 	

Table 8-1. Test Procedure—Continued

Step	Test	Procedure	Corrective action										
		5. Check resistance between 'S' and 'R' and move pendulum. Observe a smooth change of resistance from 0 to 25K ohms $\pm 5\%$ over 80°.	12										
		6. Check resistance between 'S' and 'D' and rotate pot. Observe a smooth change of resistance from 0 to 22K ohms $\pm 5\%$ over 80°.	12										
		Deviations from above requirements are cause for replacement.											
22	Angle transducer cable	Check Angle Transducer Cable P1 (79T168) per Cable Test Instruction.	13										
23	Pre-amplifier power	Install Cables P3 and P6 in LSTC Console. Remove cover to Pre-Amp on Gantry. Use D.C. Voltmeter to measure $\pm 9V$. Amplifier Power. Measure from "C" (25) to 21. Pin 21 is positive. Voltage should be between + 8.800VDC & +8.400 VDC. Record Value.											
		Measure from "C" (25) to 20. Pin "C" is positive voltage should be between -8.800VDC & -8.400VDC. Record Value.											
		Subtract and compare recorded values for the "+" & "-" Bus. These must be within .050VDC of each other.	14										
24	Load cell power	Use an A.C. Voltmeter to measure oscillator voltage on bottom terminal from "A" (23) and "B" (24).	16										
		Voltage should be 7.250VAC ± 0.02 VAC. Recheck also across upper terminal board terminal "A" (33) and "B" (34) for same voltage.											
		NOTE											
		Load cell Null temperature compensation network is mounted on upper terminal board to terminals "A", "B" and "D".											
25	Load cell pre-amp test	Apply a compressive load to load cell by listing boom point to slightly above the horizontal. (2° to 3°) Measure with an A.C. voltmeter on bottom terminal board from "C" (25) and "D" (26). The following approximate voltages should be present depending on the boom length. (Do not take readings at "C" - "D" as this is a CURRENT input to Amplifier and will not register on VOLTMETER).											
25	Load cell pre-amp test	<div><div>Pre-Amplifier</div><table><tr><th>Boom Length</th><th>Output</th></tr><tr><td>30 ft.</td><td>0.0368 VAC $\pm 10\%$</td></tr><tr><td>40 ft.</td><td>0.05504 VAC $\pm 10\%$</td></tr><tr><td>50 ft.</td><td>0.774 VAC $\pm 10\%$</td></tr><tr><td>60 ft.</td><td>1.0388 VAC $\pm 10\%$</td></tr></table></div>	Boom Length	Output	30 ft.	0.0368 VAC $\pm 10\%$	40 ft.	0.05504 VAC $\pm 10\%$	50 ft.	0.774 VAC $\pm 10\%$	60 ft.	1.0388 VAC $\pm 10\%$	17
Boom Length	Output												
30 ft.	0.0368 VAC $\pm 10\%$												
40 ft.	0.05504 VAC $\pm 10\%$												
50 ft.	0.774 VAC $\pm 10\%$												
60 ft.	1.0388 VAC $\pm 10\%$												
		These signals may also be observed using an oscilloscope. If the above readings for the specific boom length can be obtained then proceed on to next step.											
26	Function generator test	Install correct program card in LSTC Console & "Floats/Tires" Switch to be placed in proper position.											
		Reconnect Cable P-2 for Remote Indicator at LSTC Console. With boom still at near horizontal (2°-3°) which gives a load signal from the pre-amplifier to the computer then use a jumper to carry the load signal from each of the function generator amplifiers to the % capacity meter amplifier & meter. Individually connect from P1-S to P1-"D" to "R" inclusive. This should give a <i>positive</i> needle deflection on per cent capacity meter. At present disregard actual values since these are dependent on the program card used. (The per cent capacity meter may go over 100%.)	18										
27	Boom angle meter	By using a jumper the boom angle meter amplifier & meter can be checked. Meter should read "0" when connecting jumper from P1-"C" to P1-A and 90° plus when connecting from P1-"C" to P1-B.	19										
28	Boom angle	Check the high-low presets by installing the P1 Cable into the LSTC Console and adjusting her LSTC Console front panel instructions. Put boom at 45° & make checks. When test is finished, reset knobs at CCW and CW position respectively for low-high angle control.	20										
29	Orange-green trip	Raise boom so the per cent capacity meter decreases to less than 90% observe if the orange "CAUTION" light goes out and green "NORMAL" illuminates at 90% $\pm 1\%$.	21										
30	Red trip	Lower boom so the per cent capacity meter increases to 100%. Observe if red "CAP/ANGLE" light comes on at 100% $\pm 1\%$. Bell should ring also.	22										
31	Control switch test	"Lamp Test", "Zero Check", "Calibrate .35°-Full Scale" & "Alarm Check" position should function per instruction book.	23										

b. Corrective Action

- (1) Check input leads, master switch and circuit breakers. Repair or replace parts as required.
- (2) Check cable P4 per cable test procedure,

paragraph 8-5c. Also check terminals and bell. Replace defective parts.

- (3) Check cable P4 per cable test procedure. Also, check terminals and switch. Replace defective parts.

(4) Failed fuse will light knob. Replace fuse. Fuse can also be checked with ohmmeter if for some reason there is reason to doubt fuse light.

(5) Failure to obtain specified reading indicates internal failure and LSTC console and remote indicator set must be replaced.

(6) Check cable P2-P5 (79T170) per cable test procedure. Replace if defective.

(7) Remove remote indicator front panel and check leads to meter and connector. If meter is found to be defective, replace complete LSTC console and remote indicator.

(8) If circuit indicates open, replace bulb. If bulb replacement does not correct problem, remove remote indicator front panel and check wiring, leads and socket.

(9) All leads should read infinity from pins to remote indicator cabinet. Remove remote indicator front panel and repair or replace.

(10) Lack of continuity indicates an open and is cause for rejection and replacement of angle transducer.

(11) Excessive leakage is indicated by ohmmeter and is cause for rejection and replacement of transducer.

(12) Ohmic values should agree with tolerances listed; if not, this is cause for rejection and replacement.

(13) Check cable P-1 (79T168) per test cable procedure. Replace if it does not meet requirements.

(14) Failure to obtain these values indicates defective P-6 cable or P-3 cable. Remove both cables on both ends and test per test instruction. Also check leads from receptacle to terminal strip. If neither positive nor negative 9 volts is present, then check from "20" to "21" for 18 volts. Terminal "21" is positive. If this is found, then, cable P3 is bad (lead "C" - signal ground is open). Replace and continue test.

(15) Check cable P-3 for open circuit or broken lead at terminal board, per cable test instructions. Replace cable if required.

(16) If voltage is present on bottom terminal board and not on top terminal board, then, remove preamp P/C board and check all solder connectors on "A," "B," "A'" and "B'." Resolder to restore connection.

(17) If a.c. output from preamplifier is not present, then, remove "D" (36) on upper terminal board and, with the a.c. voltmeter still on C (25) and D (26), measure the a.c. voltage while turning the null pot under the cover on the preamp board. The initial reading will be low (approx. 0.050 VAC) and should increase while turning both CW and CCW to a maximum of approximately 0.160 VAC. If not present, replace preamp. If preamp is functioning, then, check oscillator voltage at end of cable P-7. Remove cable from load

cell and measure a.c. voltage from pins "A" & "B". Voltage should be 7.250 ± 0.02 VAC. If not present, check cable P-7 for defects by completely removing from machine. Check cable per cable test instructions. Replace defective cable using P&H part No. 79P400-D2. If load cell cable is not defective, then, load cell is probably defective. Test and verify if load cell is defective with an ohmmeter as follows:

Primary Winding: "A" (Black) to "B" (Brown) Pins (or leads) at load cell 58 ohms.

Secondary Winding: "C" (Green) to "D" (Red) Pins (or leads) at load cell 13,000 ohms.

NOTE

No grounds or leakage should exist when using 100K scale of ohmmeter from any pin A, B, C, or D to cell housing or connector housing. The shield of the load cell is grounded to the cell through pin "E" and should show continuity to housing. Even if the load cell windings check properly, per above, and there is no output from preamplifier with load on all and "D" connected and P-7 plug, then, load cell is defective and should be replaced.

CAUTION

If load cell is changed and/or null screw turned the Pre-Amplifier must be re-nulled. To do this boom must be lowered and spreader cables relaxed. The old load cell compensation must be removed and new supplied with load cell installed in terminal box. Also, P-7 must be reconnected to load cell and terminal board.

(18) If percent capacity meter reads zero or minus for any of 12 amplifier outputs from "D" to "R", replace complete LSTC console and remote indicator. It is normal, when connection is open from P-5 to "D" thru "R", for meter to read minus, for red warning light to be "on", and bell to ring. Also, boom angle meter will read minus.

(19) If the boom angle meter does not go to zero or deflect, the internal meter amplifier is defective since meter and cable circuit have been previously checked. The complete console and remote indicator must be replaced as a matched set.

(20) Since angle transducer, remote indicator, and associated P-1 and P-2 cables have been previously checked, the fault is internal to LSTC console, and both console and remote indicator must be replaced. If either the bell or the red "CAP/ANGLE" light does not function, then, each circuit should be checked per steps 2, 16, 17, and 18.

(21) Since remote indicator lights and P-2 - cable have been previously checked, failure for "Green"- "Orange" light to trip at $90\% \pm 1\%$ indicates that LSTC console is defective and both units must be replaced.

(22) Since bell and remote indicator cables (P-2 and P-4) have been tested previously, failure for both the red light and bell to not function indicates an internal failure of LSTC console and both units must be replaced. If *either* bell or light circuit does not function, then, each circuit should be rechecked per steps 2, 16, 17, and 18.

(23) Failure of four test positions to malfunction after previously completing test steps 1 through 30 indicates a defective LSTC console, and both matched units must be replaced.

c. *Cable Testing Procedure.* Refer to figure 8-7 and test LSTC cables as follows:

(1) Disconnect cable from both ends and also disconnect any terminals on the cable assembly.

(2) Using an ohmmeter (1 ohm scale), check for continuity pin to pin or pin to lead per the particular electrical schematic that corresponds to the cable. Continuity should be per schematic.

(3) Using an ohmmeter, check for shorts or excessive leakage from pin to pin. Refer to schematic

while doing. Ohmmeter should be set on 100K ohm scale. Meter should read infinity, no deflection allowed. (Do not touch pins of meter leads with fingers as body will give erroneous signal). Leakage is cause for rejection.

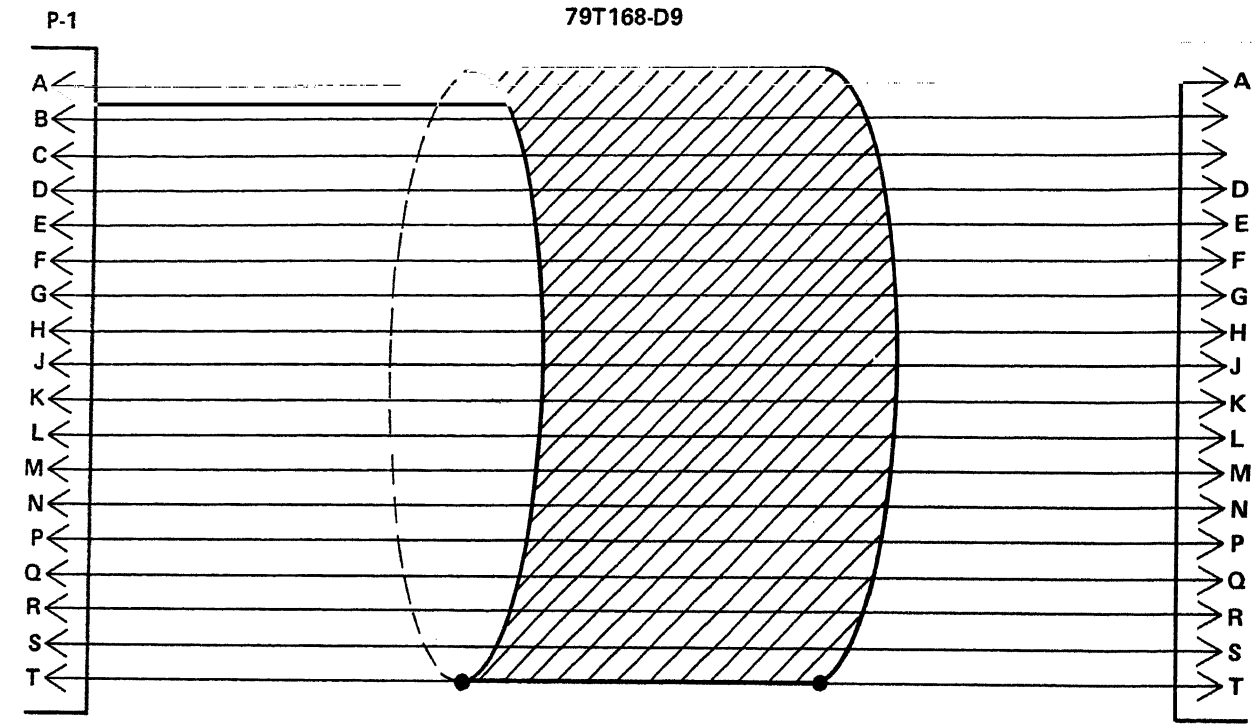
(4) Check *both* ends of cable for short or excessive leakage from each pin to connector housing. Ohmmeter should be set on 100K ohm scale. (Do not touch pins of meter leads.) Leakage is cause for rejection.

(5) Check schematic for shield if used and verify that shield is not grounded to connector housing and that shield is not open using subparagraphs (3) and (2) respectively, above. Leakage or open is cause for rejection.

(6) Check ends of cable for moisture. This can be removed by air drying or by washing connector with alcohol.

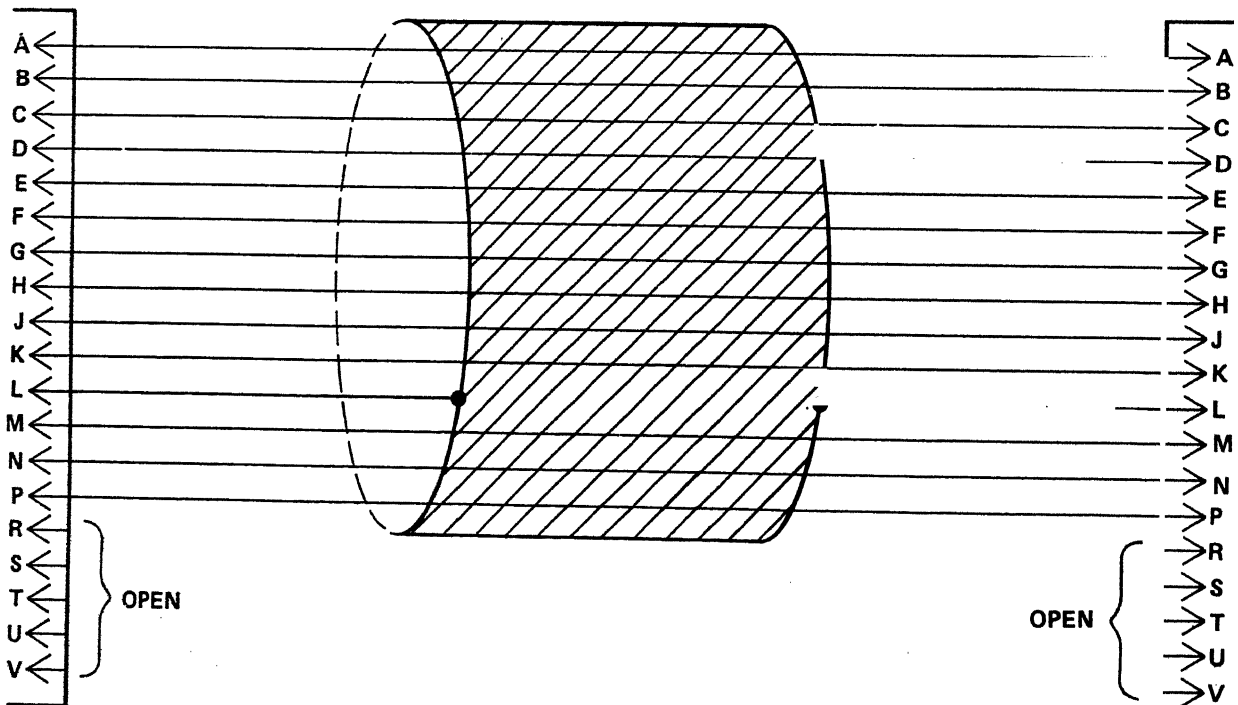
NOTE

If leakage exists, dry cable and retest before rejecting.



P-2 & P-5

79T170-D2



TA033224

Figure 8-3. Cables schematic. (Sheet 1 of 2).

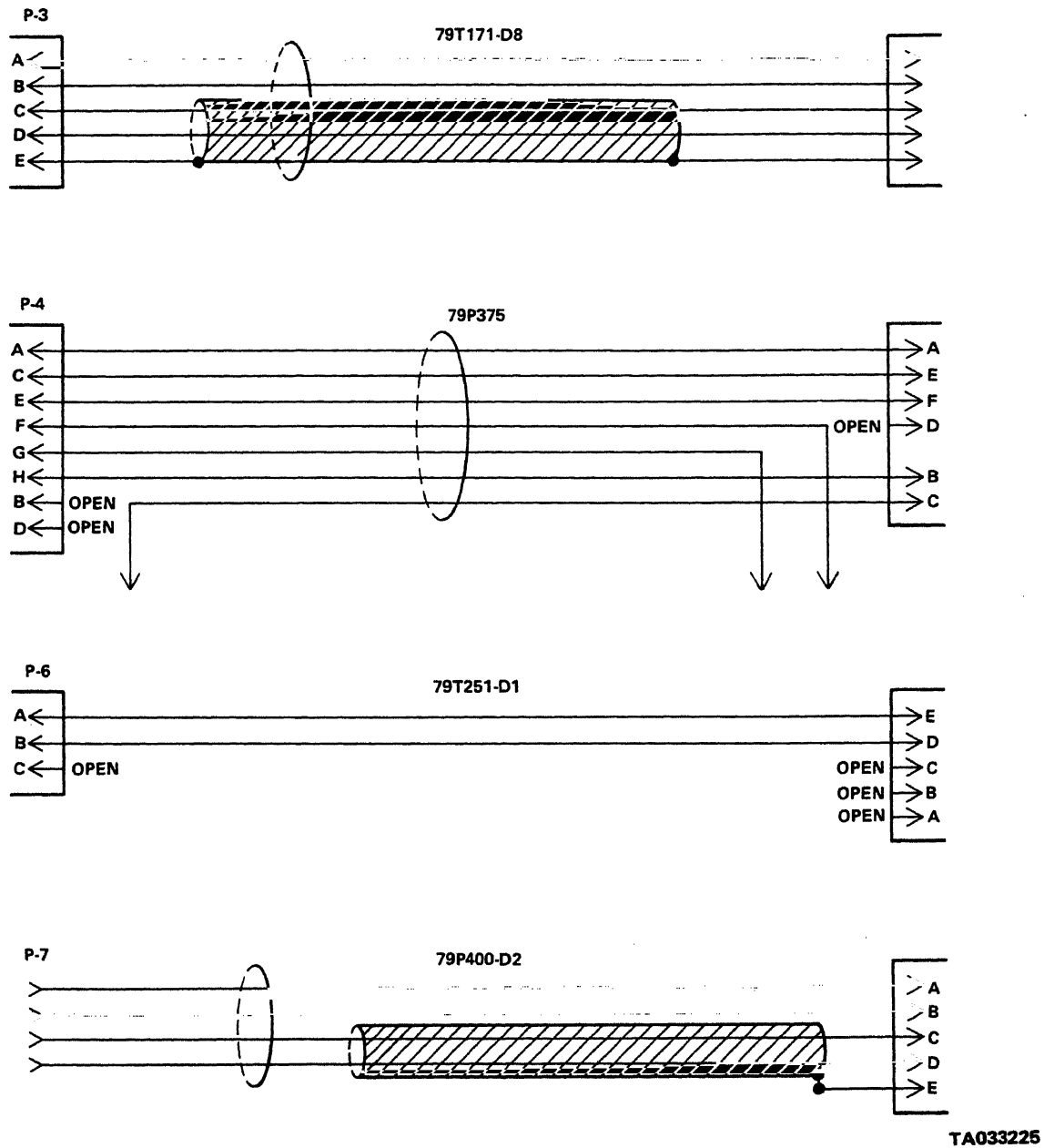


Figure 8-3. Cables schematic. (Sheet 2 of 2).

8-6. Calibration

After installing the "Lode-Safe-T" computer components, it is necessary to calibrate the computer system. The following instructions describe the procedure for properly calibrating the "Lode-Safe-T" computer.

a. *Procedure.* Calibrate the load computer as follows (see fig. 8-4)

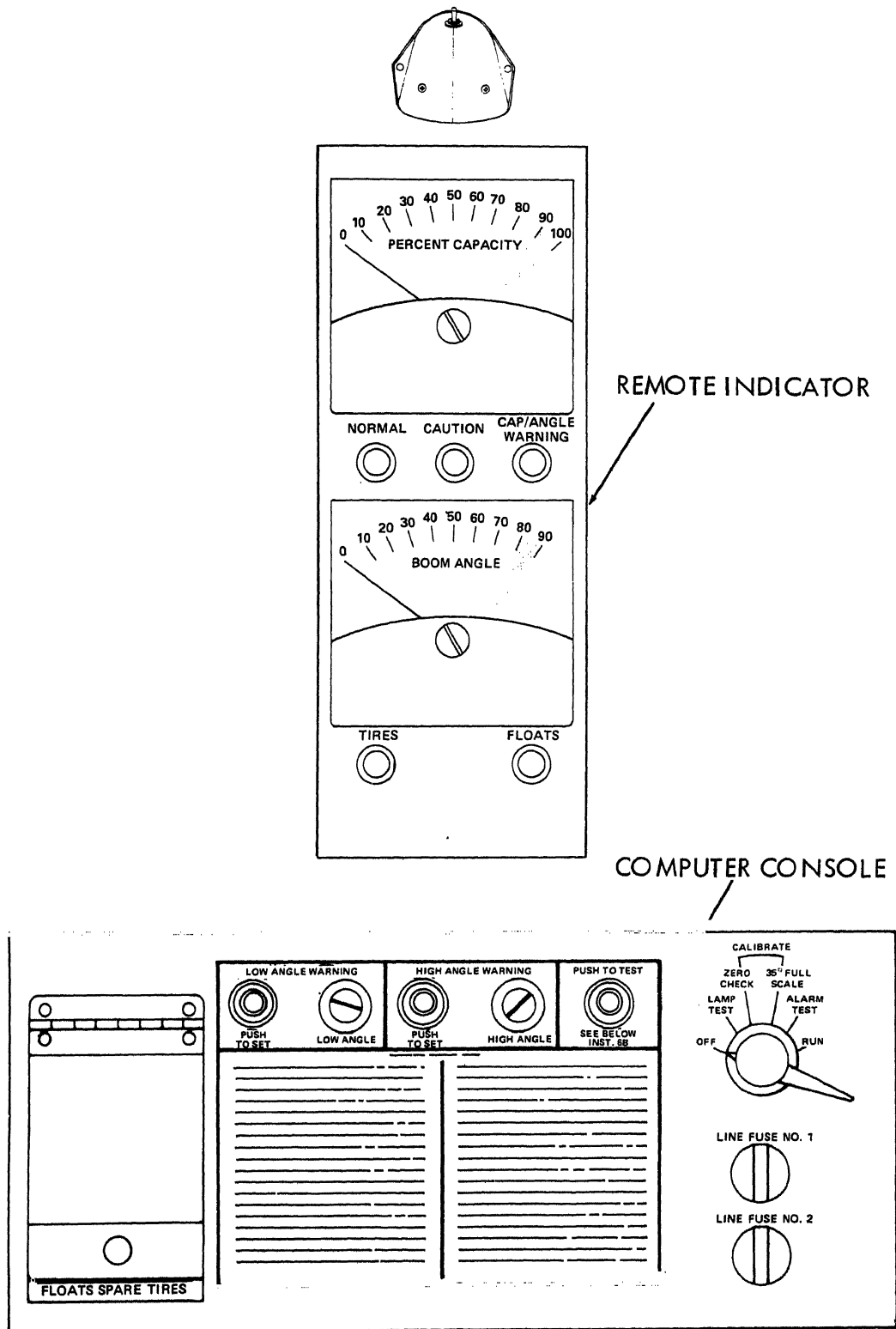
CAUTION

Under no circumstances should the seal on the computer be broken or should any internal repairs or adjustments be made. Internal repairs and adjustments can only be made at the factory with special equipment.

(1) With the boom on blocking, turn the key switch

to "on" and start the engine. With all plugs attached to the computer console and the system wired properly, the meters on the remote indicator should read "zero." If the meters indicate anything with the console switch

"off," a ground or short exists in the system. Recheck all cable routing, cable jackets, and wiring, if a short or ground exists.



TA033226

Figure 8-4. Console and remote indicator.

(2) Before turning the console switch, zero the meters, tap lightly to insure true zero. Unlock the angle transducer and set the angle warning knob on the front of the console to the extreme left position. Set the high angle warning knob to the extreme right position.

(3) Insert the proper program card for the boom to be used. Final checks can not be made without a program card inserted. Set the float/tires selector switch in the position corresponding to the card inserted.

(4) Turn the console switch to the "lamp test" position and observe that the remote indicator reads as follows:

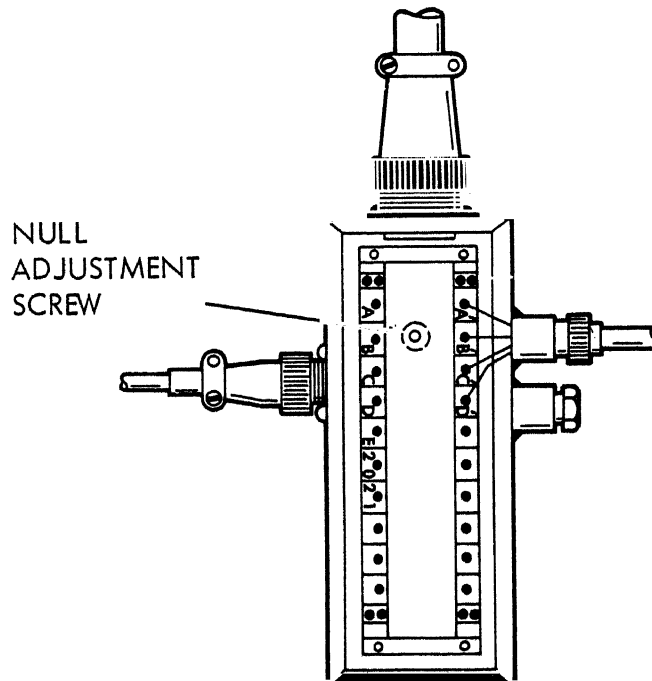
- (a) Orange and red lamps are "on"
- (b) Green lamp is "off"
- (c) Float or tires lamp is "on"
- (d) Percent capacity meter reads "100% plus"
- (e) Bell may sound.

(5) Turn the console switch to the "zero check" position. The percent capacity meter should read "zero," $\pm 1\%$ (tap lightly).

(6) Skip the "35° check" position and turn the console switch to the "alarm test" position and observe that the remote indicator reads as follows:

- (a) Orange and red lamps are "on"
- (b) Green lamp is "off"
- (c) Jib or boom lamp is "on"
- (d) Percent capacity meter reads "100% plus"
- (e) Bell sounds.

(7) Turn the console switch to the "run" position. The bell will always ring if the boom is below zero degrees or if the programming calls for it to ring until a safe operating range has been reached. With the guy lines completely slack, the percent capacity meter should read "zero." If the meter does not read "zero," remove the metal cover from the terminal box mounted on the gantry. Adjust the null pot (only) for a "zero" reading on the percent capacity meter (see fig. 8-5). Do not adjust the gain pot under any circumstances. When the percent capacity meter reads "zero," reinstall the metal cover on the terminal box.



TA033227

Figure 8-5. Null pot adjustment.

(8) Before proceeding further, determine that the truck crane is level. Raise the boom (bell may ring) to a horizontal position. As the boom is raised from horizontal, the angle meter should increase from 0°.

(9) When the boom is slightly above horizontal the percent capacity meter should be high, 50% plus. Depending upon the length of boom and its programming the meter may be over 100%. This meter reading

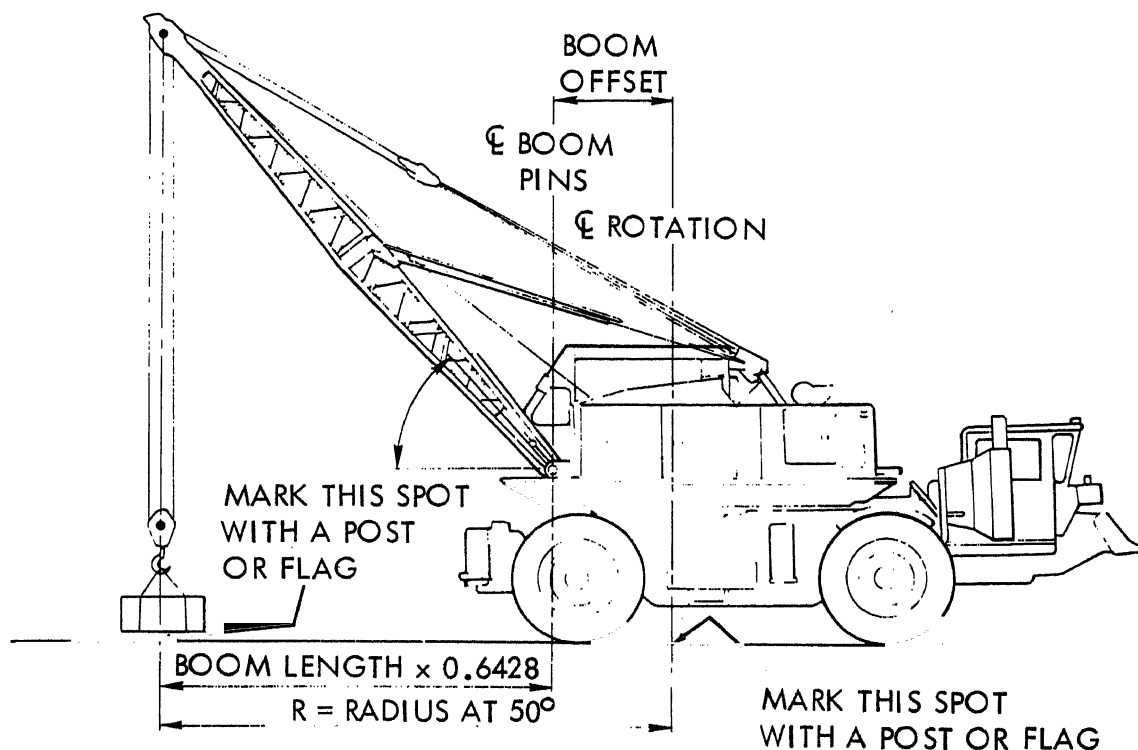
should decrease as the boom is raised to its safe operating range.

NOTE

If the percent capacity meter at any time goes above 100%, the bell should ring.

(10) Unlock the pendulum on the angle transducer, remove the cover from the transducer box, and check that it swings freely through 90°. The angle

transducer is to be calibrated for "zero" error at a 50° boom angle. Rig the machine with a single part of line and put on a load approximately equal to maximum single line load, unless this exceeds the rating plate. If the load exceeds the rating plate, use a load just below that given on the rating plate. To calibrate the transducer for zero error at 50°, the correct load radius must be calculated as follows (see fig. 8-6).



TA033228

Figure 8-6. Calculating radius at 50° boom angle.

(a) Determine the boom length on the machine.

(b) See figure 8-6 to determine the distance from the center of rotation to the center of the boom foot pins (boom offset).

(c) Determine the sheave radius by measuring from the center of the sheave pin out to the end of the sheave.

(d) The proper radius (R) is then equal to:

$$R = \text{Boom length (step (a))} \times .6428 + \text{Boom foot offset (step (b))} + \text{Sheave radius (step (c))}$$

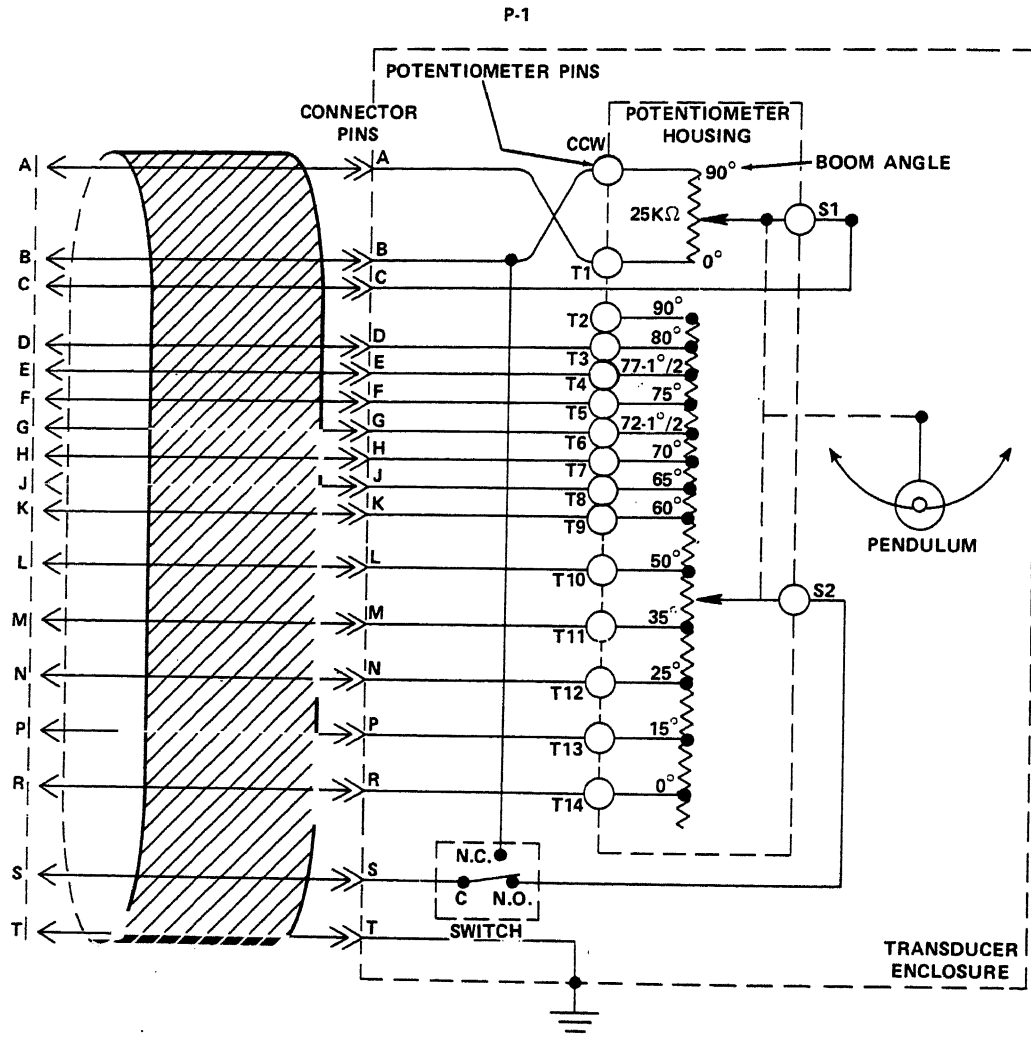
Drop a plumb bob from the center of rotation of the machine. Mark this spot with a metal post. Measure the proper radius, corresponding to the boom length for 50°, from the metal post to the end of the boom point sheave. Mark this spot on the ground. With the radius

determined and the spot marked on the ground, recheck the level of the machine, raise the boom, pick up the load and boom the center of the load exactly over the spot marked on the ground. This will put the boom at a 50° angle.

(11) Make the following adjustment while the engine is running. Remove the cable from the angle transducer box. Using an Ohmmeter measure the resistance from pins "S" to "L" in the end of the receptacle on the transducer enclosure (see fig. 8-7). Be sure the ohmmeter is zeroed every time the scale is changed. Rotate the transducer box, on the slotted holes, to reduce the reading to a minimum ohmic value. Swing the pendulum and the reading should increase in either direction when properly calibrated. Absolute

maximum ohmic value of resistance acceptable at a 50° angle, with the pendulum hanging free, is 50 ohms. Tap the enclosure to break any static friction, or run the engine at medium idle, and the pendulum should

return to approximately the same reading. If not, read just slightly so that the meter shows 50 ohms (max. when the box has been tapped, or vibrated by the engine.



TA033229

Figure 8-7. Angle transducer.

NOTE

If the transducer cannot be adjusted far enough due to the limits of the adjustment in the slotted holes, then the holes may be increased slightly and/or thinner bolts, with washers, may be used. If this is not sufficient, then the pendulum on the pot shaft must be repositioned. Rotate the transducer box on the bracket to mid-position. With the boom still at 50°, loosen the set screw on the pendulum shaft. Loosen the pendulum by turning the

pot shaft center screw with a screwdriver for a minimum ohmic value of approximately 100 ohms, across pins "S" and "L" (see fig. 8-7). Lock the set screw on the pendulum shaft. Check that the pendulum is freely swinging and the metal sector is not rubbing thru the pendulum travel. Reinstall the cover tightly. Now recheck the resistance across pins "S" and "L" and make adjustments as indicated in step (11).

(12) Tighten all mounting bolts and recheck the ohmic value. Connect the transducer cable to the angle transducer and tighten.

(13) Turn the console switch to the "35° check" position. Set the boom at a 35° angle, using the angle meter as a check. Lay hook blocks on the ground. The percent capacity meter will read $100\% \pm 10\%$. This value varies with boom variations, manufacturing tolerances, reeving, boom point sheave arrangement, etc. Booming on either side of the 35° position may make the percent capacity meter decrease, depending on the computer programming.

(14) Turn the console switch to the "run" position. The load computer is now ready for operation. Set the low and high boom angle warnings as follows (see fig. 8-4):

(a) Depress and hold the low or high boom angle warning push-to-set button. Unlock the low and high angle adjusting knobs. Turn the adjusting knob for the push-to-set button being depressed until the desired low or high boom is shown on the boom angle meter.

Repeat this procedure for the opposite boom angle.

(b) Depress the push-to-test and push-to-set buttons for either the low or high boom angle warning. The alarm bell should sound when these buttons are depressed. Repeat this procedure with the other push-to-set button.

(c) Lock the adjusting knobs in position with the lock rings.

(d) When the angle settings are exceeded, the red Cap/Angle Warning light will be lit and the alarm bell will ring.

(15) The best way to check the performance of the system is to pick up a known weight and compare it to the rating plate. A reading which is reasonably close should be acceptable since many times it is difficult to get an accurately known weight.

(16) As a safety precaution, it is recommended that the above calibration procedures be repeated daily and prior to making critical lifts. Procedures indicated in paragraphs (10), (11), and (12) above may be omitted.

CHAPTER 9

REPAIR OF CAB AND WIRING HARNESS

Section I. REPAIR OF WIRING HARNESS AND BATTERY CABLES

9-1. Cleaning and Inspection

WARNING

Disconnect battery before working on electrical system and/or components.

a. Refer to the wiring diagram in TM 5-3810-295-12 for identification if necessary.

b. Clean battery terminals and cable lugs. Clean any other wire or terminal that is corroded and in a troublesome circuit.

c. Inspect battery cables and terminal for excessive corrosion, breaks or other damage. Inspect battery acid for proper level. Inspect wiring for breaks, damage or loose connections.

9-2. Repair

Splice minor breaks in wiring, and wrap with electrical tape. Replace excessively damaged wires and terminals.

Section II. REPAIR OF CAB

9-3. Removal and Disassembly

Refer to figure 2-1 and disassemble cab components and sheet metal as required.

9-4. Cleaning, Inspection and Repair

a. Clean excessively dirty cab components with warm soapy water and dry thoroughly.

u. Inspect threaded parts for excessive wear or damage. Inspect sheet metal for breaks, cracks or other damage. Inspect weather stripping for breaks or ex-

cessive stiffness.

c. Straighten and repaint minor dents or scratches in sheet metal. Replace broken glass and damaged weather stripping. Replace all other excessively damaged parts.

9-5. Reassembly and Installation

Refer to figure 2-1 and reassemble cab parts as required.

CHAPTER 10

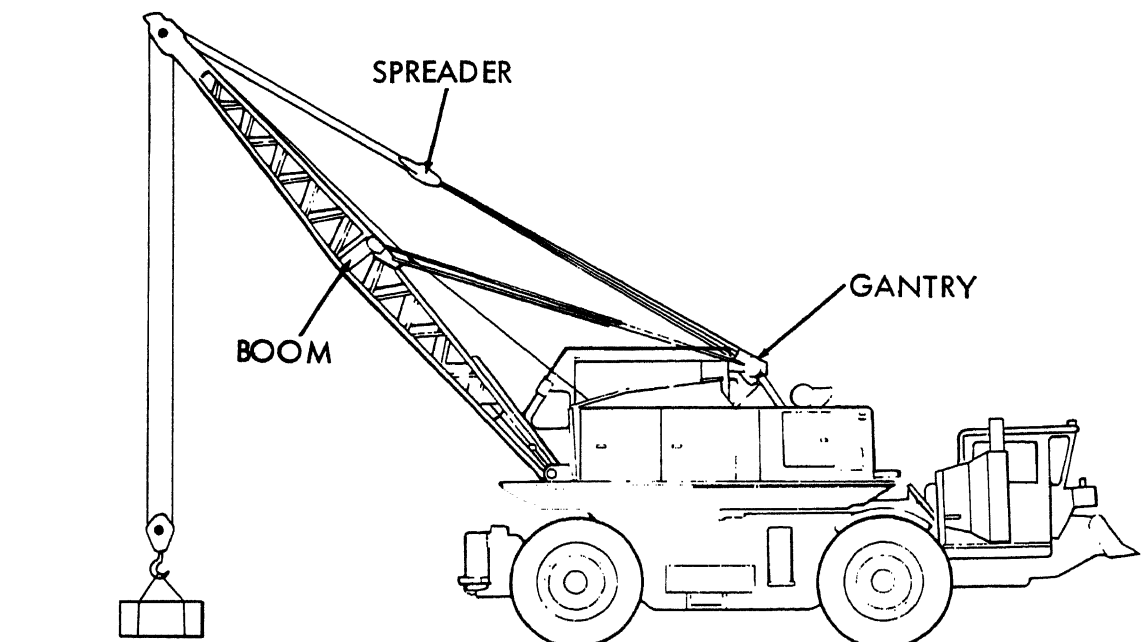
REPAIR OF CRANE GANTRY, SPREADER AND BOOM COMPONENTS

Section I. REPAIR OF GANTRY

10-1. Description

The gantry (see fig. 10-1) is the main load bearing

structure of the boom. The load lines are attached to the gantry.



TA033230

Figure 10-1. Gantry assembly.

10-2. Removal

- a. Lower boom to rest on suitable cribbing.
- b. Support gantry assembly and relieve line tension prior to disconnecting lines.

10-3. Disassembly

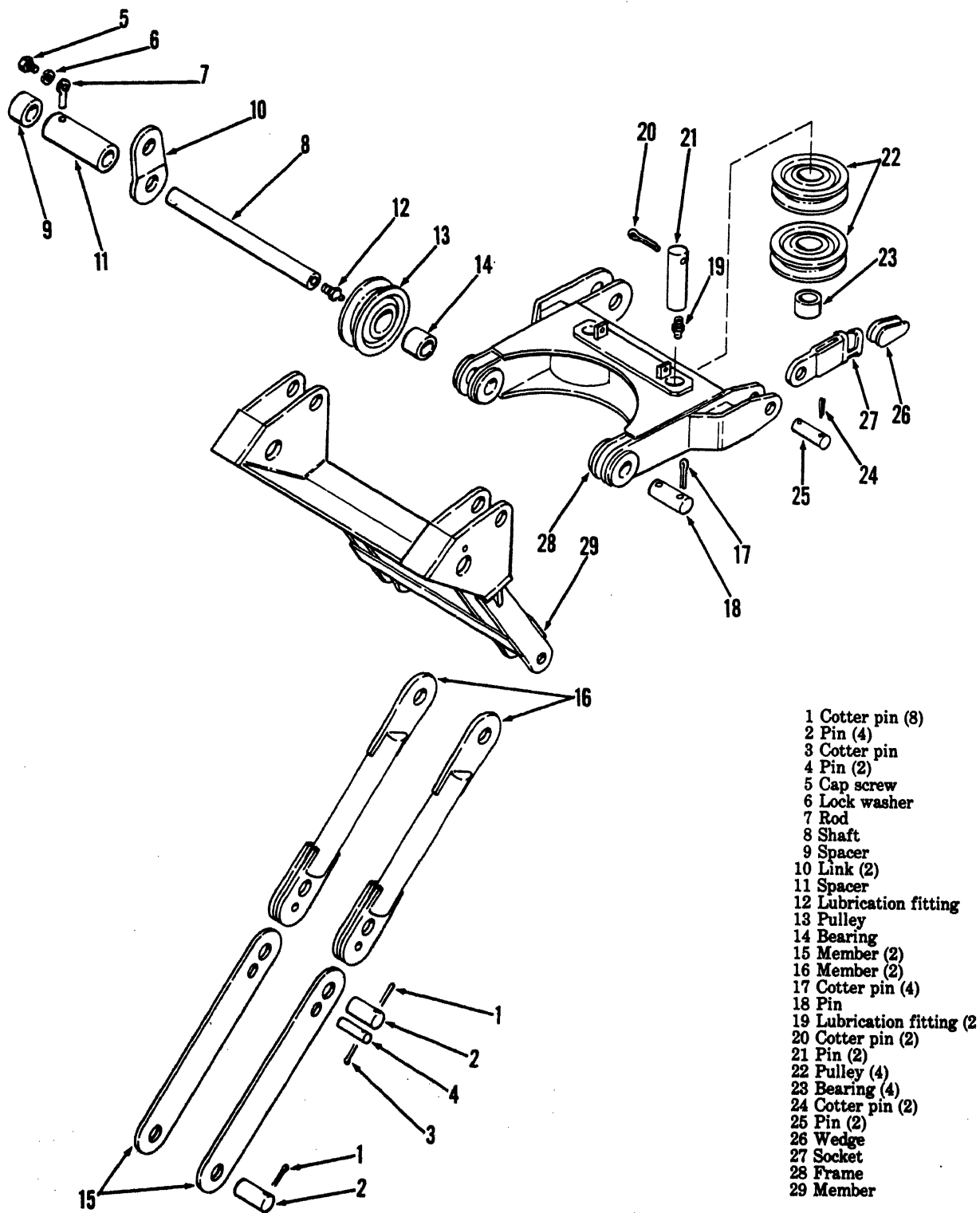
Refer to figure 10-2 and disassemble the gantry to the point required for cleaning, inspection, and replacement. Inspection can be made without disassembling the gantry using a magnetic particle method.

WARNING

Careful inspection of the gantry, following any severe snapping, whipping or jerking of the boom, is required to prevent possible damage to the crane or injury to personnel working near the crane.

10-4. Cleaning, Inspection and Repair

- a. Clean gantry parts with an approved cleaning solvent, Federal Specification P-D-680 or equivalent.



TA033231

Figure 10-2. Gantry assembly—exploded view.

b. Carefully inspect gantry parts using magnetic particle (magnaflux) method. If there is any indication of cracks or excessive wear, replace defective parts.

c. Repair of the gantry is limited to the replacement of defective parts.

10-5. Reassembly and Installation

a. Refer to figure 10-2 and reassemble the gantry as required.

b. Install the gantry as described in TM 5-3810-295-12. Lubricate as described in LO 5-3810-295-12-2.

Section II. REPAIR OF BACKSTOP

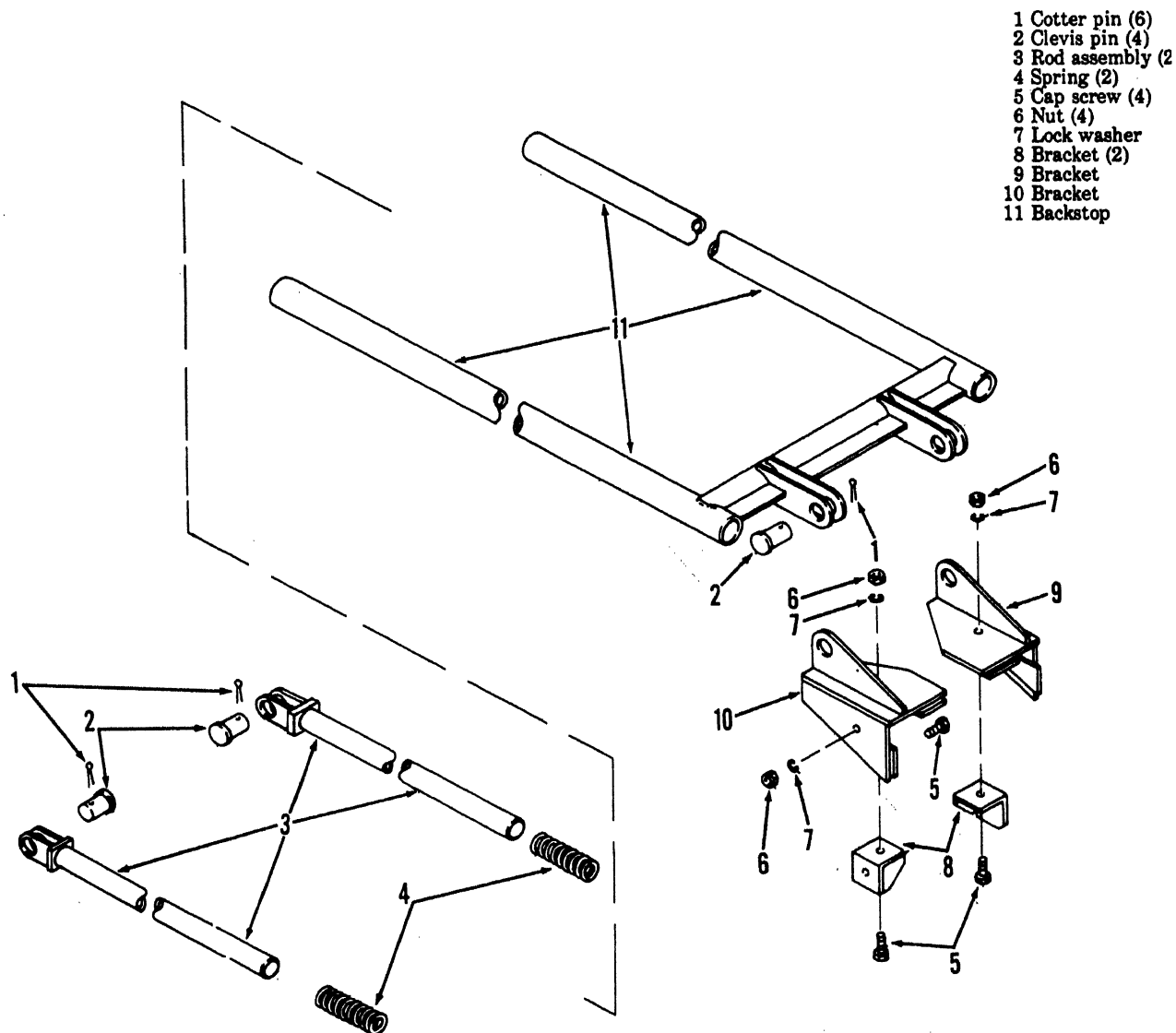
10-6. Description

The backstop (fig. 10-3) connected between the boom and gantry provides a limit to the rearward movement of the boom. It is basically made up of two spring loaded, telescoping, tubular beams.

10-7. Removal and Disassembly

a. Remove the backstop as described in TM 5-3810-295-12.

b. Refer to figure 10-3 and disassemble the boom backstop as required.



TA033232

Figure 10-3. Boom backstop assembly—exploded view.

10-8. Cleaning, Inspection and Repair

a. Clean the backstop with an approved cleaning solvent such as Federal Specification P-D-680 or equivalent.

b. Inspect the backstop for cracks, using a magnetic particle (magnaflux) method. Inspect springs for permanent set, cracks or other damage. Inspect all other parts for damage or excessive wear.

c. Repair is limited to replacement of damaged,

worn, or otherwise defective parts.

10-9. Reassembly and Installation

a. Refer to figure 10-3 and reassemble the backstop. If the rod assembly (3) has been removed, insure all old lubricant has been removed.

b. Install backstop assembly as described in TM 5-3810-295-12. Lubricate as described in LO 5-3810-295-12-2.

Section III. REPAIR OF HOOK BLOCK

10-10. Description

The hook block is attached to the boom hoist line by two pulleys (10, fig. 10-4) and is used to lift and carry loads in crane operations.

10-11. Removal

To remove hook block, lower load line to ground and disconnect cable.

10-12. Disassembly

a. Remove lubrication fittings (1, fig. 10-4). Remove cotter pins (2), pin (3), retainer (4) and shaft (5).

b. Separate plates (17) and remove guard (8). Remove spacers (6) and (7). Remove bearings (9) from pulleys (10).

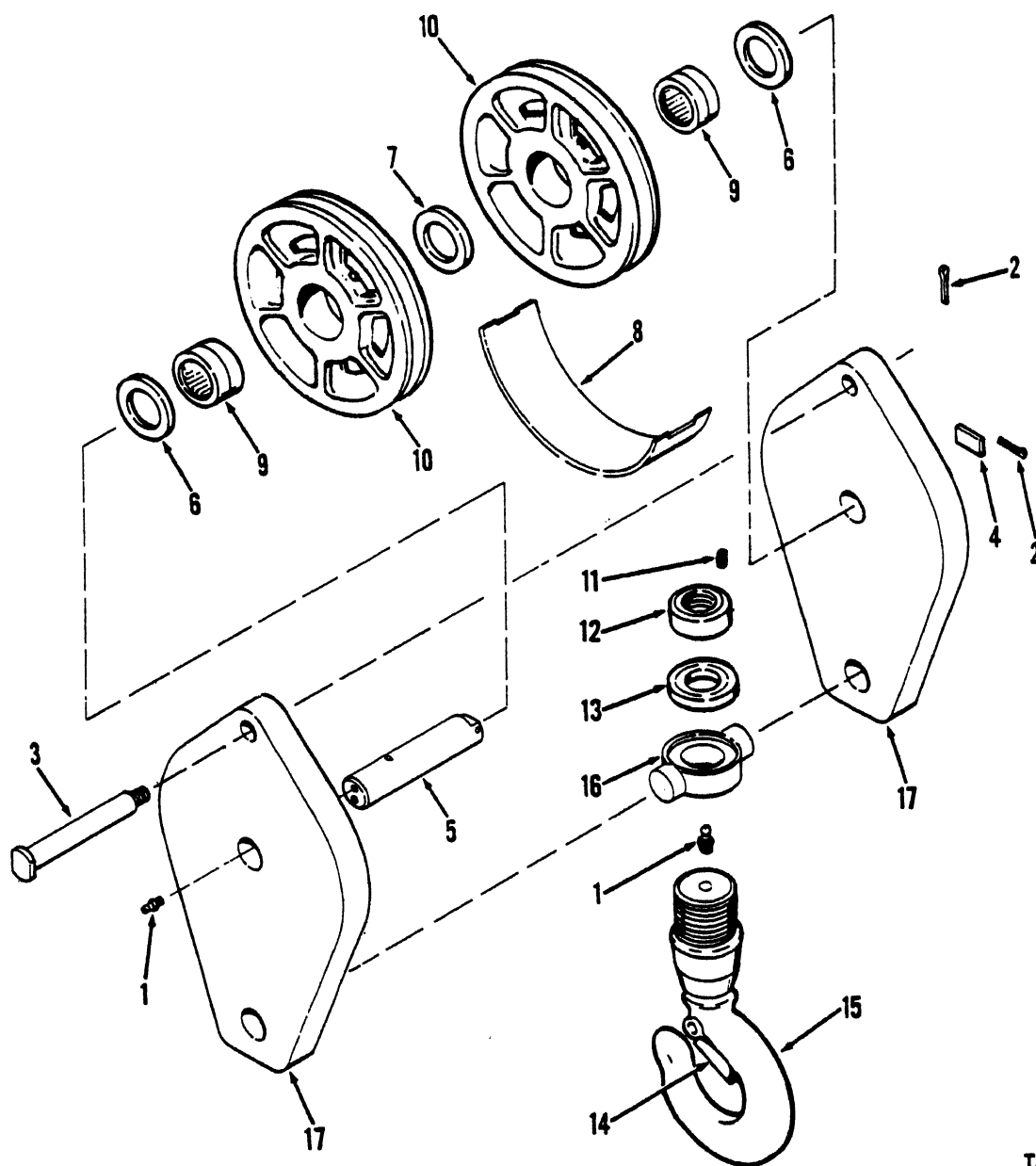
c. Loosen setscrew (11) and remove nut (12). Remove bearing (13). Remove latch (14) if damaged. Remove hook (15) from trunnion (16).

10-13. Cleaning, Inspection and Repair

a. Clean all parts with cleaning solvent, Federal Specification P-D-680 or equivalent.

b. Inspect grease fittings for damaged threads and to insure that fittings are not clogged. Repair or replace if damaged.

c. Inspect hook (15, fig. 10-4) for cracks. Replace hook if cracks are evident. Compare hook with a new hook. If more than a 15 percent increase in throat opening or a 10 percent side bend is evident, replace hook.



TA033233

- 1 Lubrication fitting (3)
- 2 Cotter pin (3)
- 3 Pin
- 4 Retainer
- 5 Shaft
- 6 Spacer (2)
- 7 Spacer
- 8 Guard
- 9 Bearing (2)
- 10 Pulley (2)
- 11 Setscrew (2)
- 12 Nut
- 13 Bearing
- 14 Latch
- 15 Hook
- 16 Trunnion
- 17 Plate (2)

Figure 10-4. Hook block assembly—exploded view.

- d. Inspect threads on hook (15) and nut (12). Replace if threads are damaged.
- e. Replace bearings (9) and (13) if damage or excessive wear is seen upon inspection.
- f. Inspect all other parts for wear, defects or other damage. Replace as necessary.

10-14. Reassembly

- a. Install hook (15) into trunnion (16). Replace bearing (13), install nut (12) and tighten setscrew (11).
- b. Install bearings (9) into pulleys (10). Position

pulleys and spacers (6) onto pin (5) as shown on figure 10-4.

c. Position the assembled hook, pulleys and guard (8) between plates (17). Install pin (3), retainer (4) and cotter pins (2). Replace lubrication fittings (1).

d. Rotate pulleys to insure bearings (9) rotate freely. Insure that hook swings freely.

10-15. Installation

Lubricate and install hook block assembly as described in TM 5-3810-295-12.

Section IV. REPAIR OF BOOM, BOOM ROLLERS AND PULLEYS

10-16. Description

- a. The boom (fig. 10-5) is in two sections, secured together by eight cap screws, lock washers, and nuts. Rollers and pulleys are mounted on the upper section (40) of the boom.
- b. The pulleys (30) provide low friction pivot points for load cable movement. Rollers (36) are used for guiding the cable and also reducing cable friction.

10-17. Removal and Disassembly

- a. Remove the boom assembly as described in TM 5-3810-295-12.
- b. Insure that the boom is adequately supported. Refer to figure 10-5 and disassemble the boom as required.

10-18. Cleaning, Inspection and Repair

- a. Clean boom parts with cleaning solvent, Federal

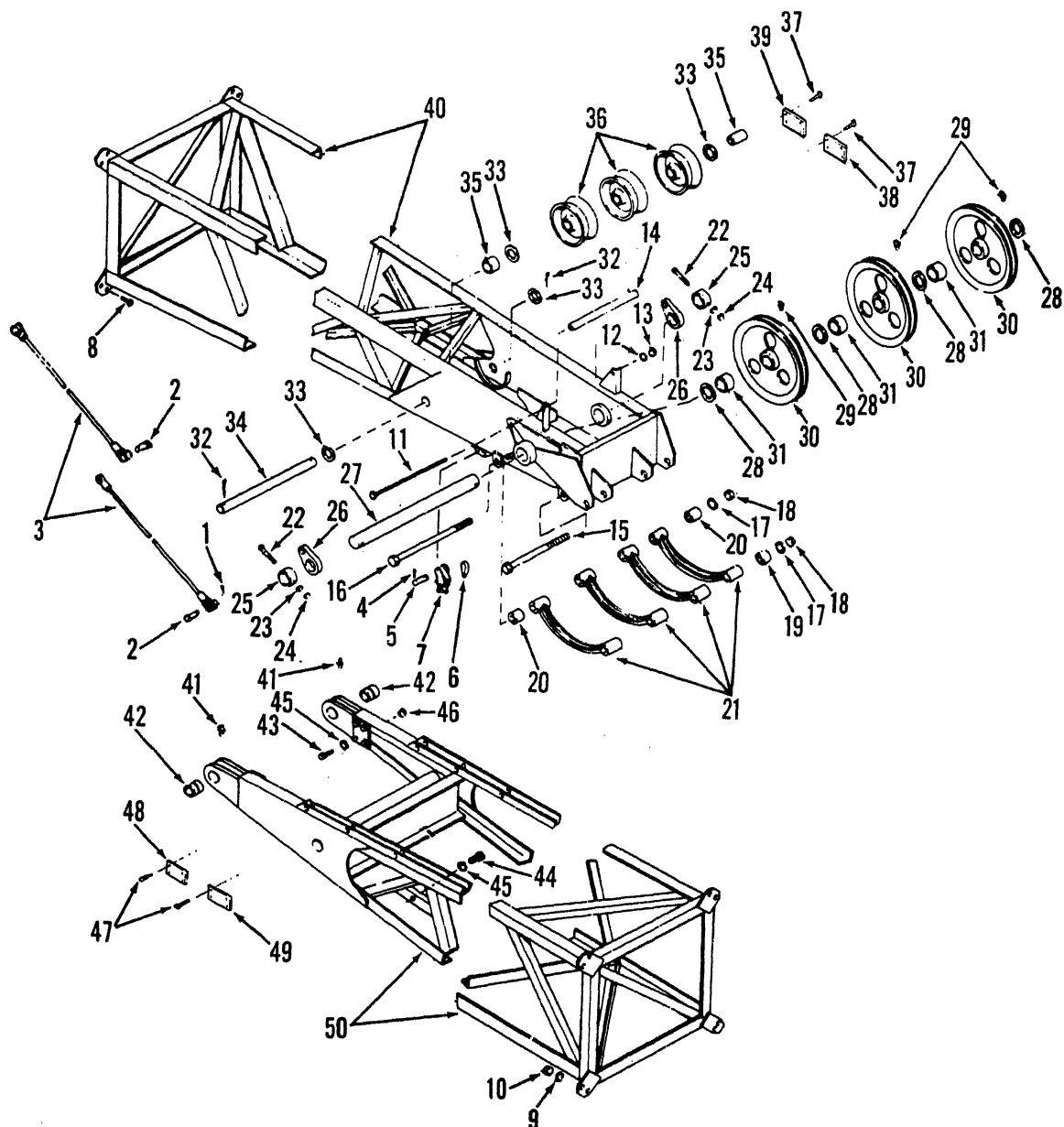
Specification P-D-680 or equivalent, and wipe dry. Make sure to remove all old lubricant.

WARNING

Boom repair is limited to component parts replacement only. Main cord angles shall not be repaired or straightened below the depot maintenance level. Lacing members may be cold straightened at direct support level. Cutting and welding of lacing and cord angles is not permitted below depot level.

b. Inspect pulleys and rollers for excessive wear or damage. Inspect bearings (31) and (42) for excessive wear or damage. Inspect all other parts for excessive wear or damage. Inspect boom and boom welds for cracks using magnet particle (magnaflux) method.

c. Corrugated grooves may be smoothed on a lathe if damage is not extensive.



TA033234

- | | | | |
|-------------------|--------------------|----------------------------|----------------------------|
| 1 Cotter pin (4) | 14 Spacer | 26 Link (2) | 38 Plate |
| 2 Pin (4) | 15 Cap screw | 27 Shaft | 39 Plate |
| 3 Wire rope (2) | 16 Cap screw | 28 Washer (4) | 40 Upper boom |
| 4 Cotter pin (2) | 17 Lock washer (2) | 29 Lubrication fitting (3) | 41 Lubrication fitting (2) |
| 5 Pin | 18 Nut (2) | 30 Pulley (3) | 42 Bearing (2) |
| 6 Wedge | 19 Spacer (2) | 31 Bearing (3) | 43 Cap screw |
| 7 Socket | 20 Spacer (2) | 32 Cotter pin (2) | 44 Cap screw (8) |
| 8 Cap screw (8) | 21 Guard (4) | 33 Washer (4) | 45 Lock washer (9) |
| 9 Lock washer (8) | 22 Cap screw (2) | 34 Shaft | 46 Nut (9) |
| 10 Nut (8) | 23 Lock washer (2) | 35 Spacer (2) | 47 Rivet (8) |
| 11 Bolt | 24 Nut (2) | 36 Roller (3) | 48 Identification plate |
| 12 Lock washer | 25 Collar (2) | 37 Rivet (8) | 49 Data plate |
| 13 Nut | | | 50 Lower boom |

Figure 10-5. Boom assembly.

d. Minor cracks on pulleys and rollers may be welded and ground. All other repairs should be limited to replacement of defective parts.

10-19. Reassembly

- a. Refer to figure 10-5 and reassemble the boom.
- b. Lubricate bearing shaft and bearing prior to in-

stallation. Insure that pulleys and rollers turn freely before installing.

10-20. Installation

Refer to TM 5-3810-295-12 and install the boom as described.

PART THREE

CARRIER

CHAPTER 11

INTRODUCTION

Section I. GENERAL

11-1. Scope

a. Part three of this manual covers repair instructions for the carrier portion of the model M320RT truck crane. Both parts of this instruction manual should be read by maintenance personnel prior to repairing the equipment.

b. Instructions covering the usage of this manual

are contained in chapter 1.

11-2. Forms and Records

For information concerning maintenance records and forms refer to chapter 1. Also covered in chapter 1 are instructions for direct reporting of errors, omissions and recommendations for improving this equipment publication by the individual user.

Section II. DESCRIPTION AND DATA

11-3. Description

a. A general description of the model M320RT truck crane and information pertaining to the identification plates are contained in TM 5-3810-295-12. Equipment operating instructions are also contained in TM 5-3810-295-12.

b. A detailed description of specific components and assemblies is contained in the applicable sections of this manual.

11-4. Tabulated Data

All tabulated data concerning the model M320RT truck crane is contained in chapter 1.

CHAPTER 12

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS AND EQUIPMENT

12-1. Special Tools and Equipment

There are no special tools or equipment needed to perform direct or general support maintenance on the M320RT truck crane carrier.

12-2. Maintenance Repair Parts

Repair parts for the M320RT truck crane carrier are listed and illustrated in the repair parts list, TM 5-3810-295-34P.

Section II. TROUBLESHOOTING

12-3. Scope

a. This section contains troubleshooting or malfunction information and tests for locating and correcting most of the troubles which may develop in the M320RT crane. Each malfunction or trouble symptom for an individual component, unit, or system is followed by a list of tests or inspections necessary for you to determine probable causes and suggested corrective actions for you to remedy the malfunction.

b. This manual cannot list all possible malfunctions that may occur or all tests or inspections, and corrective actions. If a malfunction is not listed (except when malfunction and cause are obvious), or is not corrected by listed corrective actions, you should notify higher level maintenance.

c. Table 2-1 lists the common malfunctions that you may find during the operation or maintenance of the M320RT crane or its components. You should perform the test/inspections and corrective actions in the order listed.

12-4. Troubleshooting

Refer to table 2-1 and troubleshoot the M320RT as required.

NOTE

Before you use this table, be sure you have performed all normal operational checks. If you have a malfunction which is not listed in this table, notify the next higher level of maintenance.

Section III. GENERAL MAINTENANCE

12-5. General

General maintenance is discussed in chapter 2 (paragraphs 2-5 through 2-9). Prior to attempting any disassembly

procedure, the above paragraphs should be read and adhered to.

Section IV. REMOVAL AND INSTALLATION OF CARRIER MAJOR COMPONENTS

12-6. Engine and Torque Converter

a. *General.* The engine and torque converter assembly should be removed from the carrier as a single unit.

b. *Removal.*

(1) Refer to TM 5-3810-295-12 and remove all leak plates over the engine assembly.

(2) Refer to TM 5-3810-295-12 and drain the cooling system. Remove all radiator hoses, air cleaner, duct, shroud, exhaust pipes and muffler.

(3) Refer to TM 5-3810-295-12 and disconnect battery cables, throttle linkage, air compressor lines, and engine wiring.

NOTE

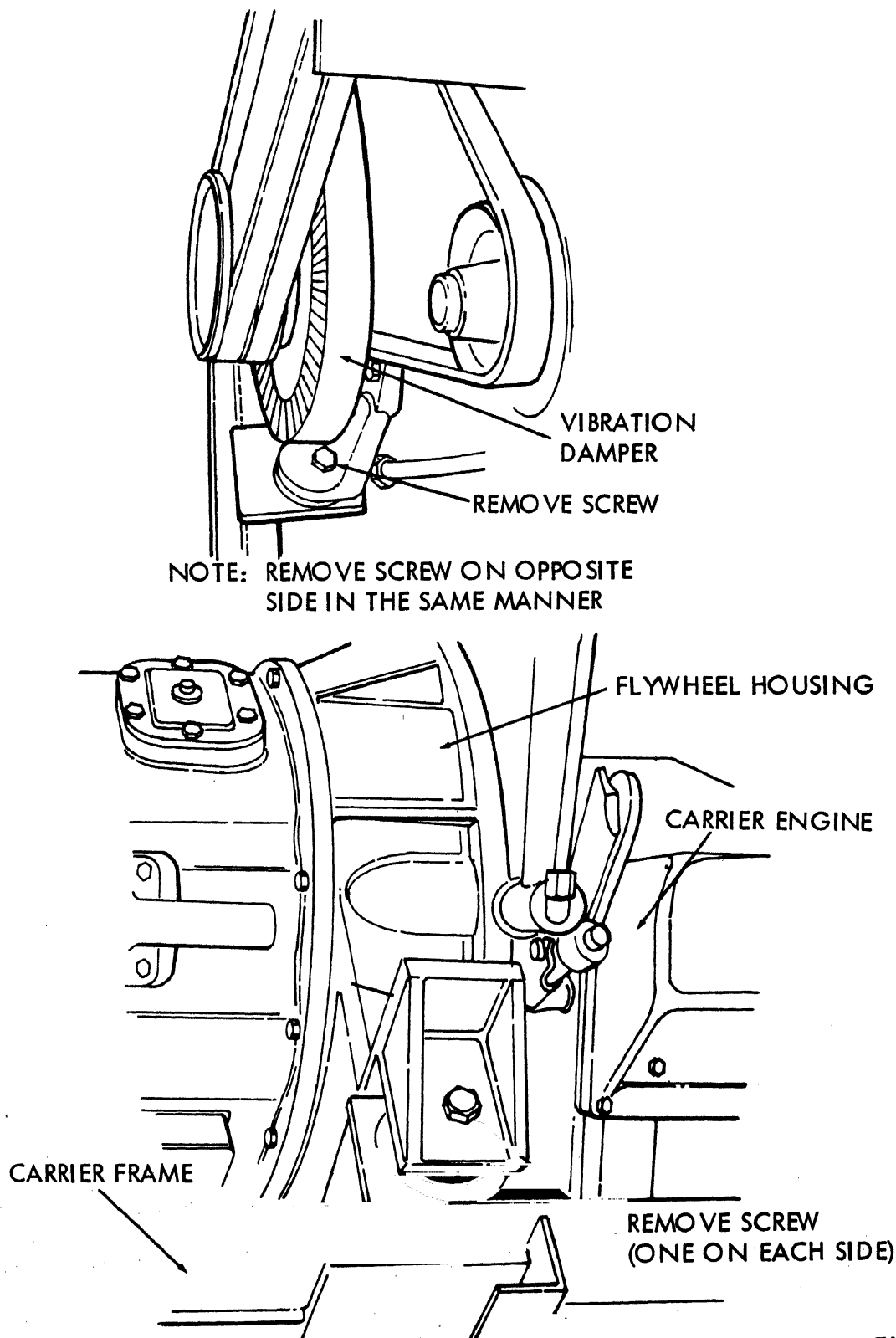
When disconnecting leads and wires, they must be identified for proper reconnection.

(4) Drain and disconnect fuel lines at the fuel pump. Cap all disconnected fuel lines immediately (TM 5-3810-295-12).

(5) Disconnect and tag all hydraulic lines.

(6) Refer to paragraph 15-8b and disconnect the universal joint from torque converter to transmission.

(7) Refer to figure 12-1, and attach a suitable lifting device to the engine. Remove engine mounting bolts and lift the engine and torque converter assembly from the carrier.

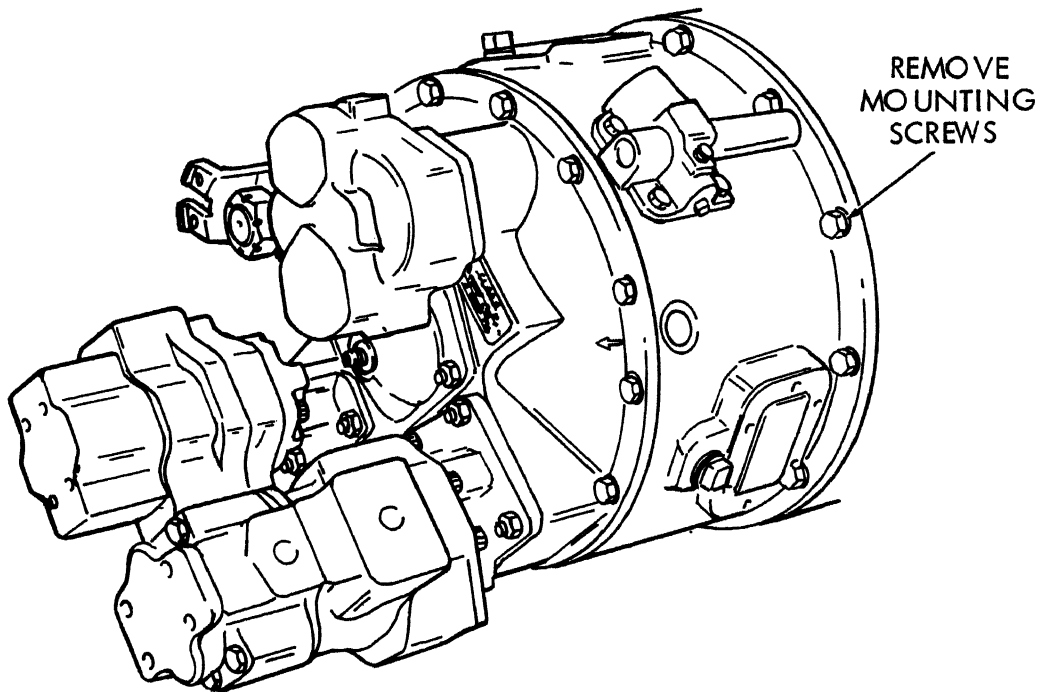


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Figure 12-1. Carrier engine mounting.

(8) Refer to figure 12-2 and attach a suitable lifting device to the torque converter. Remove torque con-

verter mounting bolts and lift the assembly from the engine.



NOTE: USE A SUITABLE LIFTING DEVICE AND REMOVE TORQUE CONVERTER ASSEMBLY.

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Figure 12-2. Carrier torque converter mounting.

c. Installation.

(1) Refer to figure 12-2 and place torque converter in position on carrier engine with a suitable lifting device. Install torque converter mounting bolts.

(2) Refer to figure 12-1 and attach a suitable lifting device to the engine. Place the engine and torque converter assembly on the carrier engine mounting brackets and install the engine mounting bolts.

(3) Refer to paragraph 15-8 and connect the universal joint from the torque converter to transmission.

(4) Connect all hydraulic lines.

(5) Refer to TM 5-3810-295-12 and connect fuel lines, engine wiring, air compressor lines, throttle linkage, and battery cables.

(6) Refer to TM 5-3810-295-12 and install the ex-

haust pipe, muffler, air cleaner, duct, shroud and deck plates previously removed.

(7) Refer to TM 5-3810-295-12 and attach radiator hoses and fill the cooling system.

12-7. Carrier Transmission Assembly

a. *General.* The carrier transmission assembly is a separate unit and can be removed without removal of the torque converter and engine assemblies.

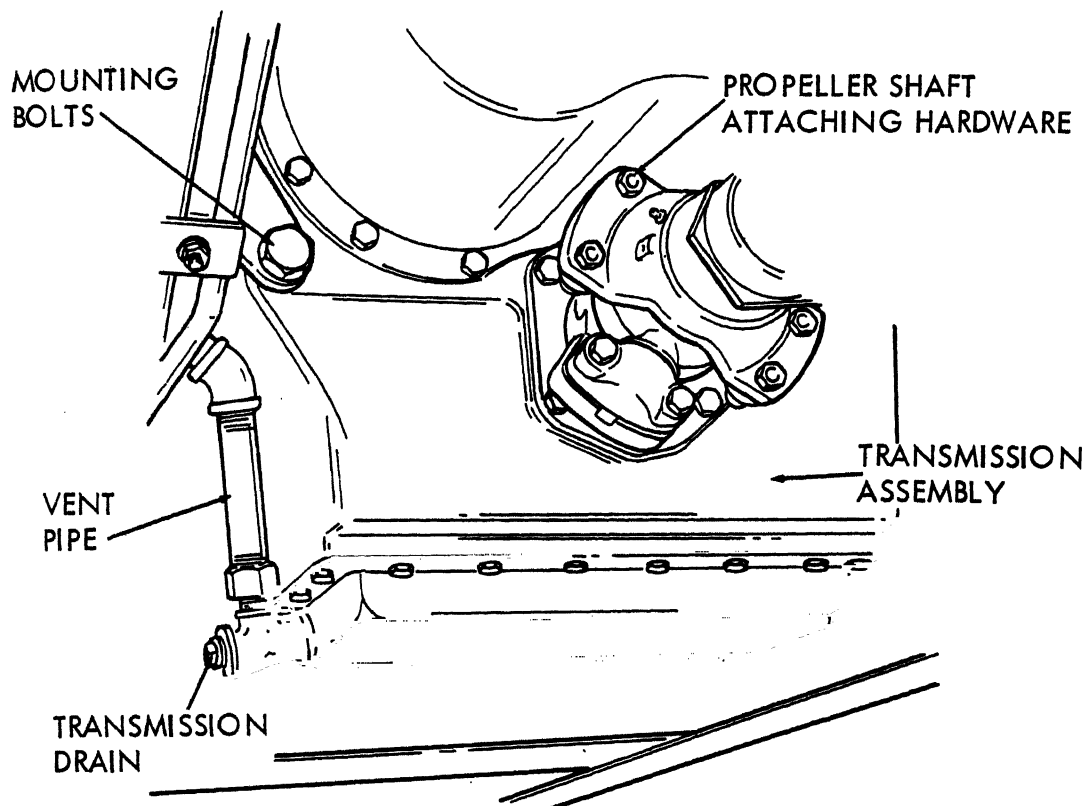
b. Removal.

(1) Refer to paragraph 15-8, and remove the propeller shafts.

(2) Disconnect and tag all hydraulic lines.

(3) Refer to figure 12-3 and with suitable support provided, remove transmission as shown.

NOTE: SUITABLE SUPPORT FOR TRANSMISSION MUST BE PROVIDED.



- STEP 1. DRAIN TRANSMISSION LUBRICANT IN SUITABLE CONTAINER.
- STEP 2. REMOVE VENT PIPE.
- STEP 3. REMOVE MOUNTING BOLTS AND LOWER TRANSMISSION TO SUITABLE SUPPORT.

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Figure 12-3. Carrier transmission removal.

- (4) Lower transmission from the carrier frame.

c. Installation.

(1) With a suitable lifting device, lift transmission in proper position against mounting brackets on carrier frame.

(2) Refer to figure 12-3 and with transmission properly supported install mounting bolts.

(3) Connect all hydraulic lines.

(4) Refer to paragraph 15-8 and install the propeller shafts.

(5) Refer to figure 12-3 and install the vent pipe as shown.

d. Service Machine after Transmission Overhaul.

(1) The transmission, torque converter and its allied hydraulic system are important links in the drive line between the engine and wheels. The proper operation of either unit depends greatly on the condition and operation of the other, therefore, whenever repair or overhaul of one unit is performed, the balance of the system must be considered before the job can be considered completed.

(2) After the overhauled or repaired transmission has been installed in the machine, the torque converter, oil cooler, filter, and connecting hydraulic system must be thoroughly cleaned. This can be accomplished several ways, and a degree of judgement must be exercised as to the method employed.

(3) The following are considered the minimum actions to be taken:

(a) Drain the entire system thoroughly.

(b) Disconnect and clean all hydraulic lines. Where feasible, hydraulic lines should be removed from machine for cleaning.

(c) Replace oil filter elements, cleaning out filter cases thoroughly.

(d) The oil cooler must be thoroughly cleaned. The cooler should be "back flushed" with oil and compressed air until all foreign material has been removed. Flushing in direction of normal oil flow will not adequately clean the cooler. If necessary, radiator should be removed from machine for cleaning, using oil, compressed air, and steam cleaner for that purpose.

CAUTION

DO NOT use flushing compounds for cleaning purposes.

(e) Remove bottom drain cover and plug from torque converter and inspect interior of converter housing, gears, etc. (Fig. 15-11). If considerable foreign material is noted, it will be necessary that converter be removed, disassembled, and cleaned thoroughly.

(f) Reassemble all components. Using OES 10 engine oil; fill torque converter and transmission through filler opening until fluid comes up to FULL mark on transmission dip-stick. Reinstall fill plug and dip-stick and run engine two minutes at (500-600 rpm) to prime torque converter and hydraulic lines. Recheck level of fluid in transmission with engine running at idle (500-600 rpm) and add quantity necessary to bring level up to FULL mark on dip-stick. Recheck with hot oil (180° to 200°).

(g) Recheck all drain plugs, connections, etc., for leaks and tighten where necessary.

12-7.1 Transmission System Testing

NOTE

The following tests consider the torque converter, transmission, charging pump, oil cooler and lines as a complete system.

a. Prior to starting engine and checking system from a hydraulic standpoint, check for mechanical defects.

(1) Make sure shift lever is properly installed and adjusted.

(2) Check shift lever for binding or restriction in travel that would prevent full engagement.

CAUTION

Do not stall out converter for more than 30 seconds continuous stall.

b. Check oil level in transmission with temperature of 180-200°F. Either work the machine or stall the converter to warm the oil.

c. To stall the converter, shift the transmission to forward and fourth speed and apply brakes. Accelerate engine to one half to three quarter throttle and hold until desired converter temperature is reached.

WARNING

Full throttle stall speed for an excessive length of time will overheat and damage the torque converter.

d. Check oil pressure at converter outlet, Fig. 12-5, Check point C.

(1) Install 100 PSI gage in converter outlet port.

(2) Converter out pressure should be 70 PSI at 2000 RPM.

(3) High converter out pressure indicates a restricted oil cooler.

e. Check charging pump output, Fig. 12-5.

(1) Install flowmeter in line between charging pump mounted on rear of torque converter and oil filters.

(2) Charging pump output for a new pump is 31 GPM at 2000 RPM.

(3) If output is less than 25 GPM at 2000 RPM, replace the charging pump.

f. Check transmission clutch pressures, Fig. 12-5, Check point A.

(1) Install 300 PSI gage in test port on transmission control valve.

(2) Run engine at low idle with converter oil temperature at 180-200°F.

(3) Shift transmission through all speed ranges and record pressure for each range.

(4) All clutch pressures must be 180-220 PSI and be equal within 5 PSI.

g. Check transmission clutch leakage, Fig. 12-5.

(1) Install a flowmeter in the line between the converter charging pump and the oil filter.

(2) Check and record pump volume at low engine idle and at 2000 RPM.

(3) Install flowmeter in "converter in line" between transmission and converter.

(4) Check and record oil volume at low engine idle and at 2000 RPM in all speed ranges.

(5) Subtract reading for each speed range from pump volume readings taken in sub-para g.(2) above. This is transmission clutch leakage.

(6) If clutch leakage varies more than one gallon, or if total leakage of all clutches exceeds four gallons, repair the transmission.

h. Check torque converter lube flow, Fig. 12-5.

(1) Disconnect "converter return line" at the transmission.

(2) Run engine at 2000 RPM for 15 seconds and drain resulting oil flow from the "converter return line" into a suitable container.

(3) Measure the oil and multiply by four. The result is GPM leakage.

(4) If leakage exceeds 5 GPM, repair the torque converter.

i. Check Transmission Lube Pressure, Fig. 12-5, Check Point E.

(1) Install 50 PSI gage in transmission control valve.

(2) With engine running at high idle, lube pressure should be 25 PSI.

(3) Low pressure indicates clogged oil cooler.

(4) High pressure indicates internal restriction in transmission.

12-8. Carrier Drive Steer Axles

a. *General.* The combination drive-and-steer-type axle is utilized for both front and rear axles on the carrier. The removal and installation is similar for both axles.

b. Removal

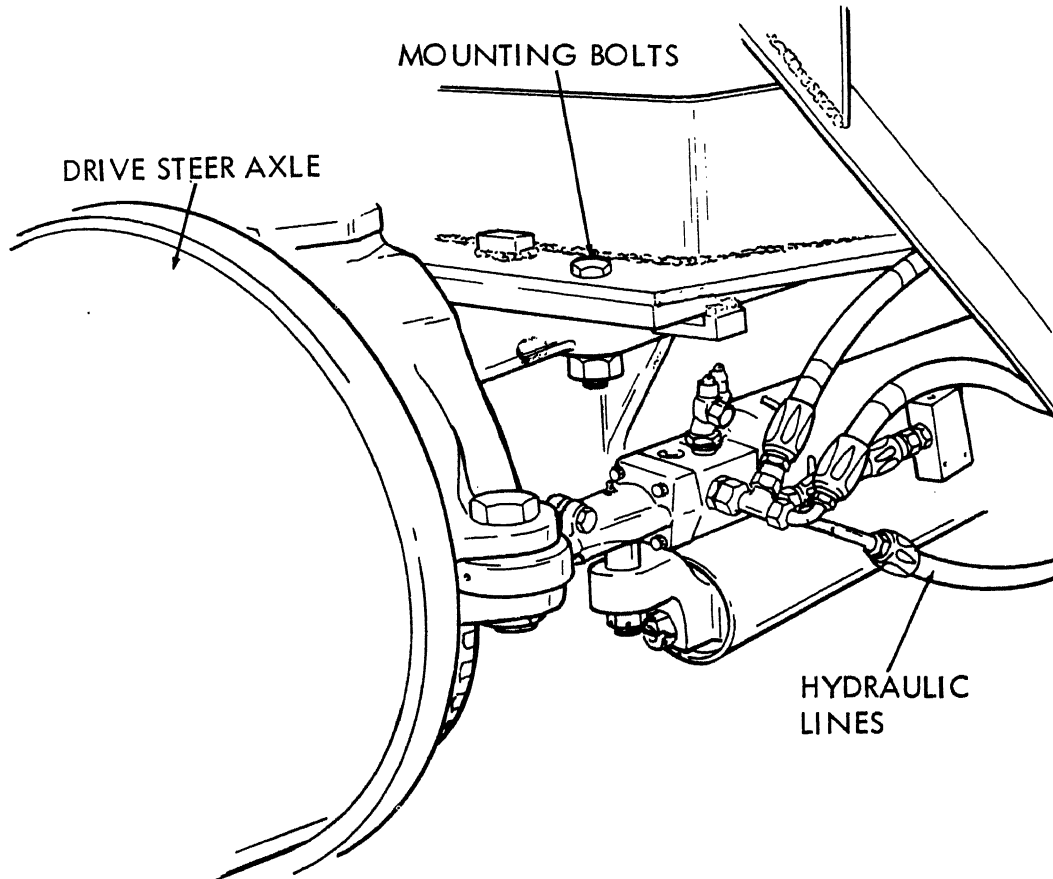
(1) Refer to figure 12-4, and crib up carrier frame or provide suitable supports.

(2) Refer to paragraph 15-8 and disconnect propeller shafts from the axle.

(3) Tag and disconnect hydraulic lines to the three steering cylinders.

(4) Remove axle mounting bolts and with a suitable supporting device remove axle from vehicle.

NOTE: BOTH FRONT AND REAR AXLES ARE REMOVED IN A SIMILAR MANNER



- STEP 1. TAG AND DISCONNECT HYDRAULIC LINES AS REQUIRED. CAP LINES TO PREVENT FOREIGN MATERIAL FROM ENTERING LINES.
- STEP 2. REMOVE MOUNTING BOLTS.
- STEP 3. PROVIDE SUITABLE SUPPORT AND REMOVE AXLE ASSEMBLY.

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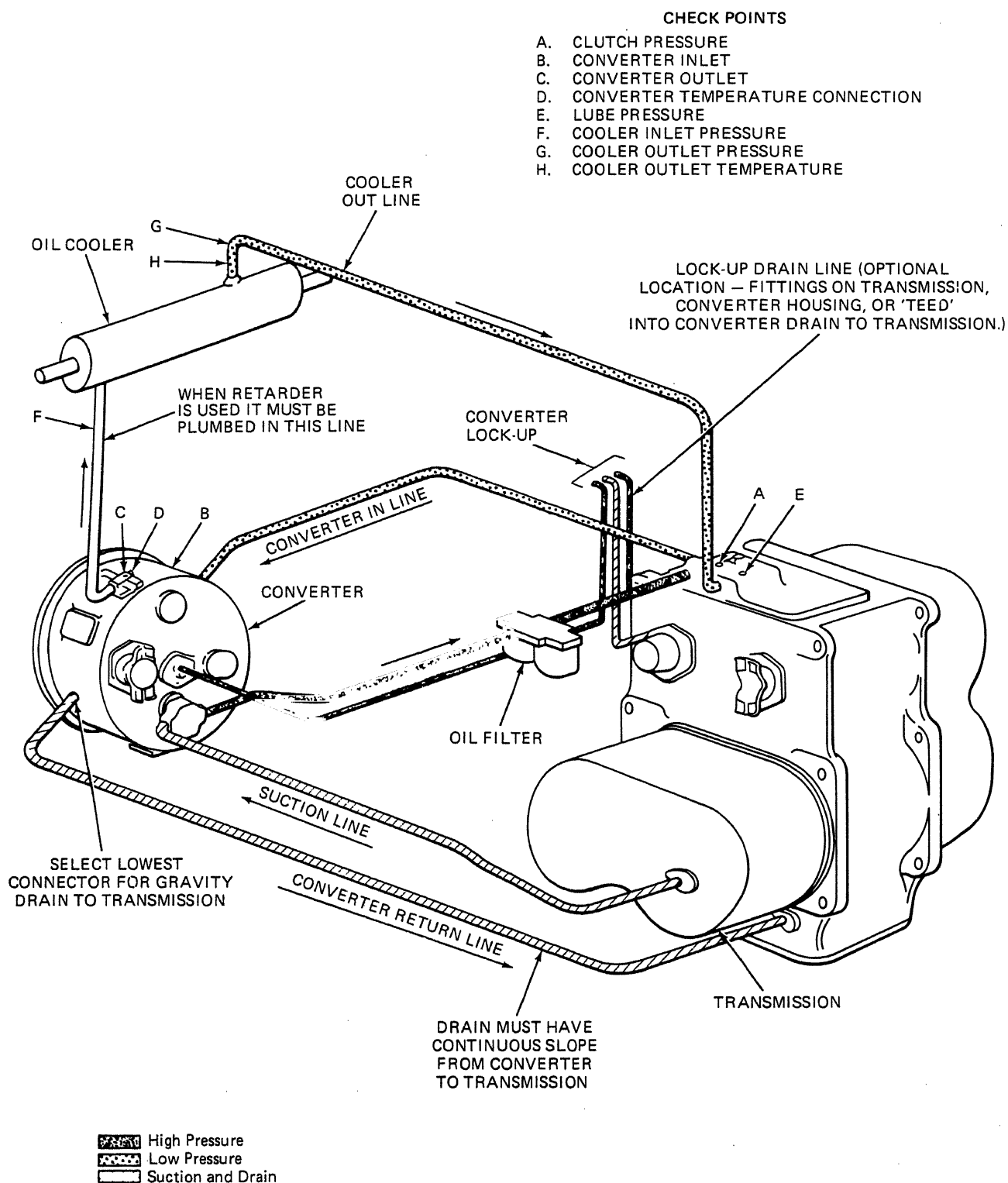
Figure 12-4. Carrier drive steer axle removal.

c. Installation.

- (1) Refer to figure 12-4 and place axle in proper position on carrier frame. Install mounting bolts.
- (2) Connect hydraulic lines previously removed

from the three steering cylinders.

- (3) Refer to paragraph 15-8 and reconnect propeller shafts to the axle assembly.



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Figure 12-5 Transmission oil flow and test points.

CHAPTER 13

REPAIR OF CARRIER ENGINE ACCESSORIES

Section I. STARTING MOTOR

13-1. Description

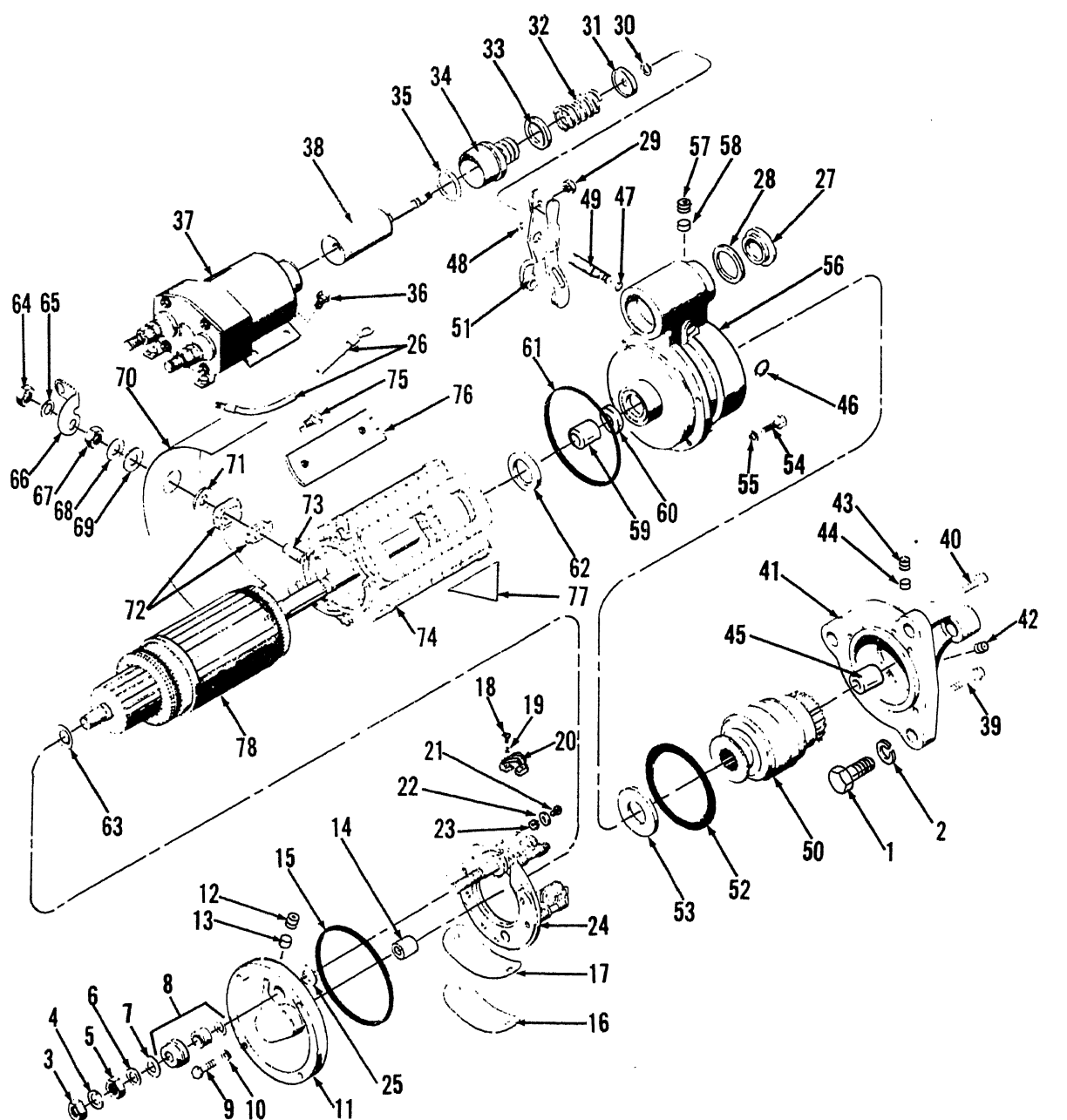
The engine starting motor is a 24-volt, gear drive type, designed for high-torque, short-use application. The starter converts electrical energy from the battery into mechanical energy to crank the engine. It engages the engine flywheel ring gear and cranks the engine until it starts. When the engine starts, the starter automatically disengages from the flywheel ring gear.

13-2. Removal and Disassembly

a. Remove the engine starting motor according to the instructions in TM 5-3810-295-12.

b. Refer to figure 13-1 and disassemble the starting motor as follows:

(1) The relative position of the solenoid (37), lever housing (56) and drive housing (41) should be marked. The motor must be reassembled with the housings in the same relative position.



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- | | | | | |
|----------------------|--------------------|----------------------|--------------------------|--------------------|
| 1 Screw | 17 Gasket | 33 Spring retainer | 49 Shaft | 64 Nut |
| 2 Lock washer | 18 Screw | 34 Boot | 50 Drive clutch assembly | 65 Lock washer |
| 3 Nut | 19 Lock washer | 35 Washer | 51 Shift lever assembly | 66 Connector |
| 4 Lock washer | 20 Brush | 36 Screw | 52 Preformed packing | 67 Nut |
| 5 Nut | 21 Screw | 37 Solenoid | 53 Brake washer | 68 Lock washer |
| 6 Lock washer | 22 Lock washer | 38 Plunger | 54 Screw | 69 Washer |
| 7 Washer | 23 Washer | 39 Screw | 55 Lock washer | 70 Coil insulator |
| 8 Insulator | 24 Plate assembly | 40 Screw | 56 Lever housing | 71 Washer |
| 9 Screw | 25 Washer | 41 Drive housing | 57 Plug | 72 Bushing package |
| 10 Lock washer | 26 Lead | 42 Plug | 58 Wick | 73 Stud |
| 11 Frame | 27 Plug | 43 Plug | 59 Bushing | 74 Field winding |
| 12 Plug | 28 Gasket | 44 Wick | 60 Oil seal | 75 Screw |
| 13 Wick | 29 Nut | 45 Bushing | 61 Preformed packing | 76 Shoe pole |
| 14 Bushing | 30 Snap ring | 46 Snap ring | 62 Spacer | 77 Insulator |
| 15 Preformed Packing | 31 Spring retainer | 47 Preformed packing | 63 Washer | 78 Armature |
| 16 Plug | 32 Spring | 48 Snap ring | | |

Figure 13-1. Starting motor—exploded view.

(2) Screws (1) and lock washers (2) are removed during the starter removal procedures.

(3) Remove nut (3), lock washer (4), nut (5), lock washer (6), washer (7), and insulators (8). Remove screws (9), lock washers (10), and frame (11).

(4) Disassemble frame (11) by removing plug (12) and wick (13). If required remove bushing (14). Remove and discard packing (15).

(5) Remove plug (16) and gasket (17). Remove screws (18), lock washers (19), and brushes (20). Remove screws (21), lock washers (22) and washers (23). Separate plate assembly (24) from frame (11). Remove washer (25). Remove electrical lead (26) from the assembly.

(6) Remove inspection plug (27) gasket (28) and adjusting plunger nut (29) from the lever housing.

(7) Compress solenoid plunger spring and with a suitable snap ring pliers remove snap ring (30). Remove spring retainer (31), spring (32), spring retainer (33), boot (34), and washer (35).

(8) Remove screws (36) and lift solenoid (37) from the housing. Slide plunger (38) from the solenoid.

(9) Remove screws (39) and (40). Separate drive housing (41) from lever housing (56). Remove plug (42), plug (43), and wick (44). Remove bushing (45) from drive housing (41) if necessary.

(10) With snap ring pliers remove snap ring (46) from lever shaft (49). Remove packing (47) and (48) and slide lever shaft (49) from lever (51). Slide drive assembly (50) from the armature shaft. Remove lever (51) from lever housing (56).

(11) Remove packing (52) and brake washer (53) from lever housing (56).

(12) Remove screws (54) and lock washers (55). Separate lever housing (56) from the starter assembly. Disassemble housing by removing expansion plug (57) and wick (58).

(13) Remove bushing (59) and seal (60) from lever housing, if required. Remove and discard packing (61).

(14) Remove spacer (62) and washer (63) from armature assembly (78).

(15) Remove nut (64), lock washer (65), switch connector (66), nut (67), lock washer (68) and washer (69). Lift coil insulator (70) off stud (73) and remove washer (71) and bushing package (72).

(16) Slide armature (78) from field windings (74), taking care not to damage the windings or insulation.

(17) Remove pole shoe screws (75) with a pole shoe screwdriver. Remove pole shoes (76) using a spreader.

(18) Remove terminal stud (73) and insulation (77) from field windings (74).

13-3. Cleaning

a. Clean all metal parts except the drive clutch assembly (50) with dry cleaning solvent, Federal Specification P-S-661, and dry all parts thoroughly with compressed air. Clean the drive assembly with a

clean cloth.

b. Clean the commutator with No. 00 sandpaper.

CAUTION

Do not clean drive assembly (50), armature (78) or field windings (74) in a degreasing tank or with grease dissolving solvents. These would dissolve the lubricants and damage the insulation.

13-4. Inspection and Repair

a. Replace all seals, gaskets and packings.

b. Check all housings for cracks or other damage. Inspect all sealing surfaces for cracks, pitting or rough spots. Replace any parts found to be damaged.

c. Inspect the commutator end frame. If it is cracked or distorted, replace.

d. Inspect the armature bearing surfaces. If they are worn replace the armature. Check the commutator. If it is worn, dirty, out-of-round, or has high insulation, it may be turned down on a lathe. After turning down, undercut the insulation one thirty-seconds of an inch wide and deep. Sand the commutator lightly with No. 00 sandpaper.

e. Remove all dirt and copper dust with compressed air and test the commutator bars for opens, shorts, and grounds, using a growler or test lamps.

f. Test field windings with a lamp. Replace field coil if the tests indicate opens or shorts.

g. Replace worn or cracked brushes and damaged brush springs. Inspect the boot for deterioration and the solenoid spring for damage. Replace all defective parts.

h. Replace the shift lever if it is cracked or distorted. Inspect the teeth on the drive assembly and replace the assembly if the teeth are worn or damaged.

i. Replace all snap rings and all hardware with stripped threads or other damage.

13-5. Reassembly and Installation

a. Refer to figure 13-1 and reassemble the engine starter motor as follows:

(1) Install bushing package (72), washer (71) and coil insulator (70) on stud (73). Carefully install field windings (74) into starter housings. Install insulation (77) between the coil and frame.

(2) Set pole shoes (76) in place and secure the shoes with pole shoe screws (75), using a pole shoe screwdriver.

(3) Install washer (69), lock washer (68), nut (67), switch connector (66), lock washer (65), and nut (64) on terminal stud (73).

(4) Install oil seal (60) into hub of lever housing (56) and press bushings (59), (45) and (14) into their respective housings.

(5) Install new packing (61) and place lever housing (56) on starter frame. Secure housing with lock washers (55) and screws (54).

(6) Place spacer (62) on armature (78) and install armature into the field frame and lever housing. Care must be used not to damage insulation or field windings.

(7) Install brake washer (53) on the armature shaft (78). Place lever (51) on drive assembly (50) and install the assembly on the armature shaft and into the lever housing.

(8) Install lever shaft (49) through the lever housing and lever, install packings (47) and (48), and secure the lever with snap ring (46).

(9) Install new packing (52) and install drive housing (41) on lever housing (56). Secure the drive housing with screws (39) and (40).

(10) Install washer (35), boot (34), spring retainer (33), spring (32), spring retainer (31) on plunger (38). Compress spring and install ring (30) on plunger. Place plunger (38) through lever (51) and install adjusting nut (29), gasket (28) and plug (27).

(11) Install solenoid (37) and secure with screws (36).

(12) Install brush (20) on plate assembly (24) with lock washers (19) and screws (18). Install washers (25) on the plate assembly studs and mount plate (24) on frame (11). Secure with washers (23), lockwashers (22) and screws (21).

(13) Install washer (63) on end of armature. Install new packing (15), and place frame (11) on starter housing. Secure frame to housing with lock washers

(10) and screws (9).

(14) Install insulators (8), washers (7), lock washers (6) and nuts (5). Install electrical lead (26) and secure with lock washer (4) and nuts (3).

(15) Install gasket (17) and plug (16) on plate assembly (24).

(16) Saturate oil wicks (58), (44) and (13) with oil and install the wicks and plugs (57), (43) and (12) in their respective positions. Install plug (42) in drive housing (41).

(17) Check the drive pinion clearance as outlined in the following:

(a) Disconnect field coil connection from solenoid. Connect a battery of the same voltage as the solenoid, to the solenoid switch terminal and to the solenoid frame or ground terminal.

(b) Momentarily flash a jumper from the solenoid motor terminal to the solenoid frame or ground terminal. This places the starter drive into cranking position.

(c) With a feeler gage measure the clearance between the drive pinion and bushing (45). Adjust clearance with adjusting nut (29) to a value of 0.010—0.015 inch.

(d) Remove jumpers and replace connection between field coil and solenoid.

b. Refer to TM 5-3810-295-12 and install the starting motor on the engine.

Section II. REPAIR OF ALTERNATOR

13-6. Description

The alternator is an air-cooled, 28-volt, 60-ampere type, with self contained silicon rectifiers. A solid state voltage regulator, with an externally accessible voltage adjustment, is built into the alternator.

13-7. Removal and Disassembly

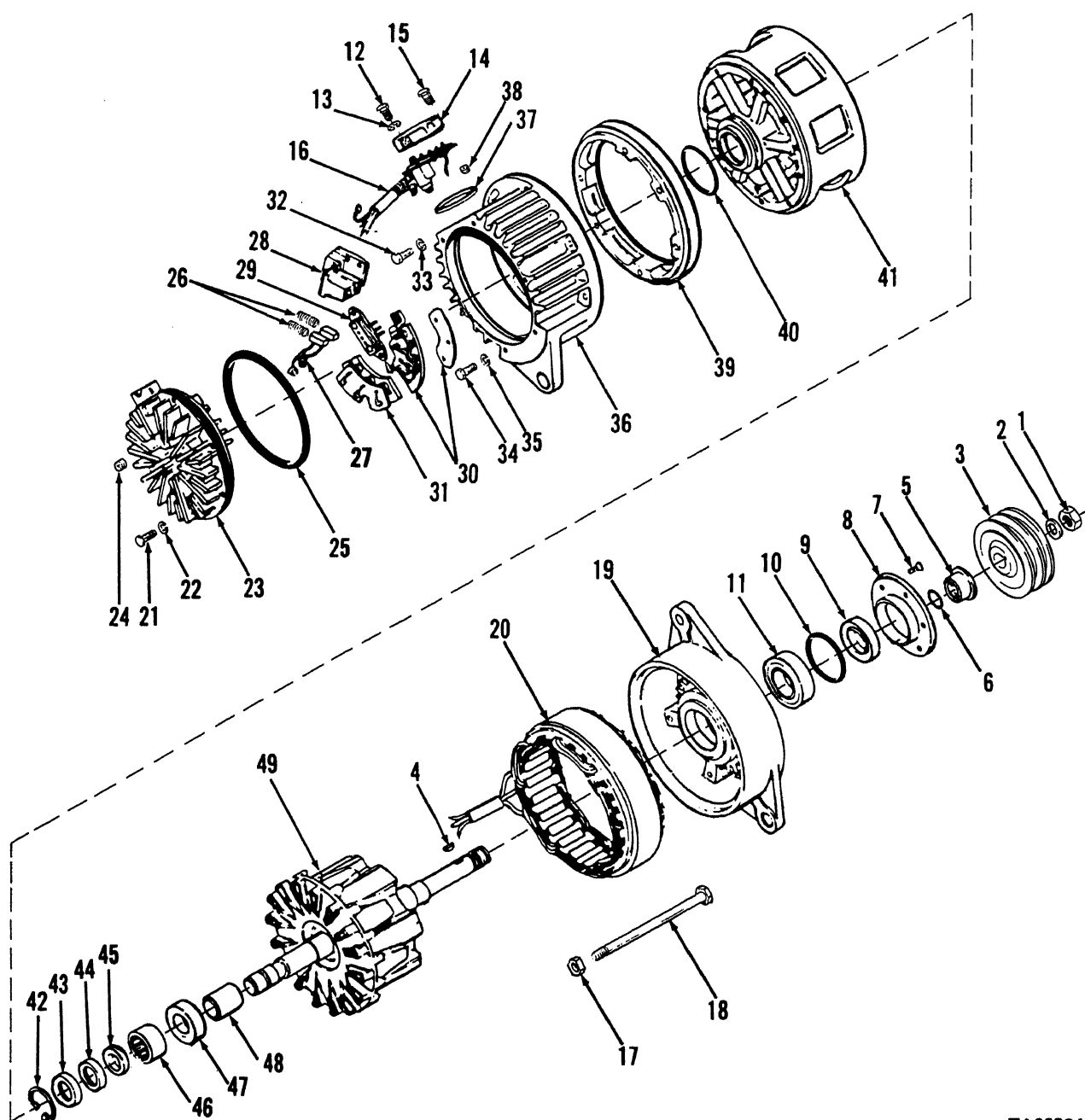
a. Refer to TM 5-3810-295-12 and remove the alternator according to the instructions.

b. Refer to figure 13-2 and disassemble the engine alternator as follows:

(1) Remove nut (1) and washer (2). With a suitable puller remove pulley (3). Remove key (4), flange (5), and preformed packing (6).

(2) Remove screws (7) and pull flange (8) from the drive end housing. Remove seal (9), packing (10) and bearing (11) from the rotor shaft.

(3) Remove screws (12), lock washers (13), and remove cover (14) from housing (36). Remove screws (15) and lift terminal board (16) sufficiently to disconnect electrical leads. Mark leads as removed.



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- | | | | |
|----------------------|--------------------------|-----------------------------|-------------------------|
| 1 Nut | 14 Cover | 26 Brush spring | 38 Plug |
| 2 Washer | 15 Screw | 27 Brush | 39 Thermal insulator |
| 3 Pulley | 16 Output terminal board | 28 Brush holder | 40 Preformed packing |
| 4 Key | 17 Nut | 29 Regulator terminal board | 41 Intermediate housing |
| 5 Flange | 18 Thru-bolt | 30 Rectifier | 42 Retaining ring |
| 6 Preformed packing | 19 Drive housing | 31 Rectifier | 43 Thrust washer |
| 7 Screw | 20 Stator | 32 Screw | 44 Seal |
| 8 Flange | 21 Screw | 33 Lock washer | 45 Seal |
| 9 Sleeve seal | 22 Lock washer | 34 Screw | 46 Bearing |
| 10 Preformed packing | 23 Cover assembly | 35 Lock washer | 47 Seal |
| 11 Bearing | 24 Plug | 36 Slip ring housing | 48 Bushing |
| 12 Screw | 25 Preformed packing | 37 Preformed packing | 49 Rotor |
| 13 Lock washer | | | |

Figure 13-2. Alternator—exploded view.

(4) Remove nuts (17) and thru-bolt (18). With a suitable puller, pull drive end housing (19) from armature shaft.

(5) Carefully remove stator (20). Do not damage electrical leads while removing stator.

(6) Remove screws (21) and lock washers (22). Pull cover (23) from slip ring housing. Remove plug (24) and packing (25) from cover (23).

(7) Remove brush springs (26), brushes (27), and brush holder (28). Remove regulator terminal board (29) and rectifiers (30) and (31).

(8) Remove screws (32) and (34), lock washers (33) and (35). Remove slip ring end housing (36), preformed packing (37), and plug (38). Remove thermal insulator (39) from the intermediate housing.

(9) Remove preformed packing (40) and press intermediate housing (41) off the armature shaft.

(10) Remove retainer ring (42), washer (43), seals (44) and (45), bearing (46), seal (47), and bushing (48) from rotor (49).

13-8. Cleaning

a. Clean all metal parts with dry cleaning solvent, Federal Specification P-S-661, and dry thoroughly with compressed air.

b. Remove all dirt, dust, and foreign matter from the housings and fields with compressed air.

13-9. Inspection and Repair

a. Inspect all electrical parts for frayed or damaged insulation. Check for bare spots on all varnish and epoxy coated parts. Recover if necessary.

b. Check rotor for wear on bearing surfaces and for loose or damaged slip rings. If worn or damaged replace rotor.

c. Inspect all parts for excessive wear or other damage. Repair or replace all defective parts.

d. Discard all packings and seals removed. Replace with new parts.

e. With stator leads disconnected, connect a test light from each stator winding lead to the stator core. If the bulb lights, the stator is grounded and must be replaced.

f. Connect the test light between each winding of the stator. If the bulb does not light, the stator winding is open and stator should be replaced.

g. Using a standard ohmmeter, measure rotor coil resistance by connecting ohmmeter across the two slip rings on the shaft. Reading shall be approximately 7.0—8.0 ohms. If the measured resistance is not within the requirements, rotor coil is defective.

h. Rotor coil shall be checked for grounds by con-

necting the ohmmeter between either slip ring and the shaft. If a reading is obtained coil is grounded. If the coil is defective or slip rings badly worn, the complete rotor assembly shall be replaced.

i. Check rectifier assemblies by checking across diodes in both directions. One direction of each diode shall have a low resistance, the other direction shall be high. If the diodes read low in both directions, they are shorted and rectifier assemblies shall be replaced.

13-10. Reassembly and Installation

a. Refer to figure 13-2 and reassemble alternator as described in the following:

(1) Press bushing (48), seal (47) and bearing (46) on the shaft of rotor assembly (49). Place seals (45) and (44) and thrust washer (43) on rotor shaft. Secure with retaining ring (42).

(2) Place intermediate housing (41) over rotor shaft, seat properly on bearing (46). Install preformed packing (40) and insulator (39).

(3) Assemble plug (38) to slip ring end housing (36). Press housing (36) over rotor shaft. Secure to insulator (39) and housing (41) with screws (32) and (34) and washers (33) and (35).

(4) Install rectifiers (31) and (30) on housing (36). Install regulator terminal board (29).

(5) Install brushes (27) and brush spring (26) in brush holder (28). Install brush holder in housing (36).

(6) Place new preformed packing (25) in groove of cover (23). Install plug (24) in cover. Install cover assembly (23) to housing (36). Secure with lock washers (22) and screws (21).

(7) Install stator (20) in housing (19). Press or tap stator to install in housing. Press bearing (11) into drive housing (19) and press housing on to rotor shaft. Make electrical connections of stator leads. Secure drive housing (19) to intermediate housing with thru-bolts (18) and nuts (17).

(8) Install terminal board (16) and secure with screws (15). Install cover (14) and secure to housing (36) with washers (13) and screws (12).

(9) Install new preformed packing (10) to flange (8). Press sleeve seal (9) on rotor shaft and install flange (8). Secure with screws (7).

(10) Place new preformed packing (6) in groove of flange (8). Slide flange (5) on rotor shaft and insert key (4) in slot provided in shaft. Press pulley (3) on shaft; proper alignment must be maintained. Secure with washer (2) and nut (1).

b. Install alternator on engine as described in TM 5-3810-295-12.

Section III. LUBRICATION OIL COOLER

13-11. Description

The oil cooler is a counterflow tube and shell type heat exchanger. The cooler maintains the lubricating oil

temperature above 140°F for most efficient lubrication, using coolant from the engine radiator.

13-12. Removal and Disassembly

a. Refer to figure 13-3 and remove oil cooler as follows:

(1) Drain the cooling system by opening drain cock on the bottom of the oil cooler.

(2) Remove screws (1) and washers (2). Lift the cooler from the engine. Remove gaskets (3) and (4).

b. Disassemble oil cooler as described in the following:

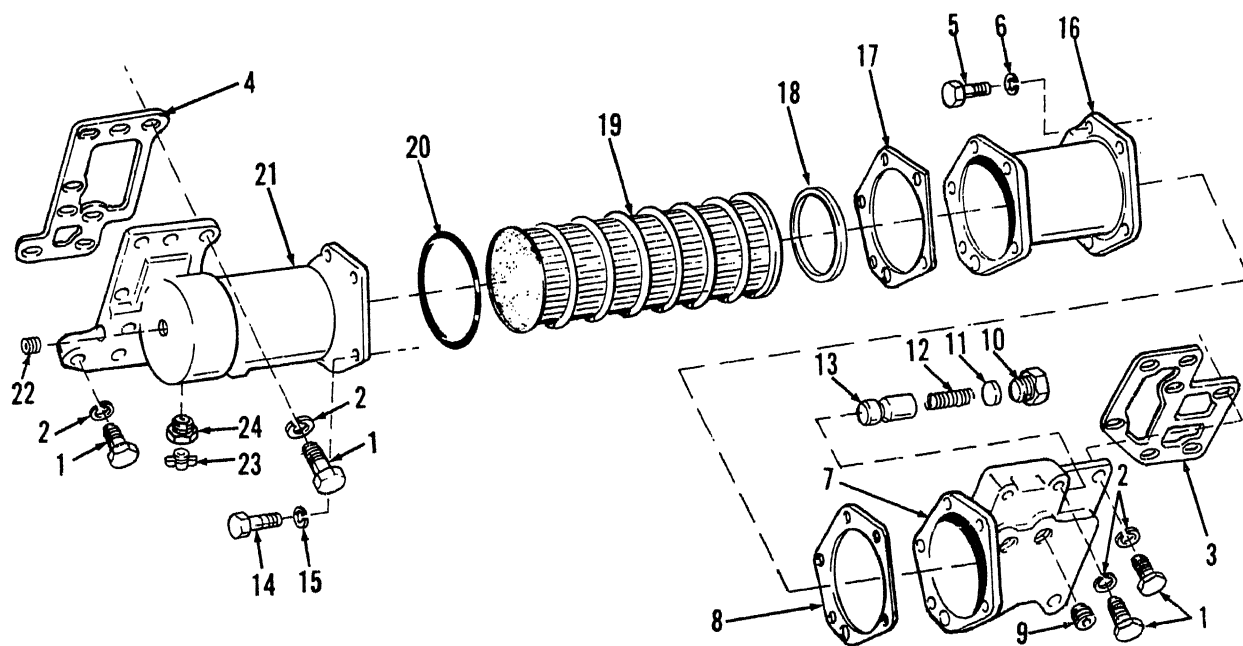
(1) Remove screws (5) and washers (6). Separate housing cover (7) from housing spacer (16) and remove

gasket (8).

(2) Disassemble cover assembly (7) by removing plug (9), cap (10), shim (11), spring (12), and plunger (13).

(3) Remove screws (14) and washers (15). Carefully pull housing spacer (16) from housing (21) without damaging element (19).

(4) Remove gasket (17) and retainer (18). Pull element (19) from housing (21) without damaging element.



TA033241

1 Screw
2 Washer
3 Gasket
4 Gasket
5 Screw
6 Washer
7 Housing cover
8 Gasket

9 Plug
10 Cap
11 Shim
12 Spring
13 Plunger
14 Screw
15 Washer
16 Housing spacer

17 Gasket
18 Retainer
19 Element
20 Preformed packing
21 Housing
22 Plug
23 Drain cock
24 Bushing

Figure 13-3. Oil cooler—exploded view.

(5) Remove preformed packing (20) and disassemble housing (21) by removing plug (22), drain cock (23), and bushing (24).

13-13. Cleaning

a. Clean all traces of gasket material from the cylinder block and cooler components.

b. Force cleaning solvent, Federal Specification P-D-680, or equivalent, through the coil passages to remove the carbon and sludge.

NOTE

Clean core as soon as possible after removal to prevent hardening and drying out of foreign substances.

c. Clean badly clogged oil passages by circulating an oakite or alkaline solution through the core. After cleaning, flush thoroughly with hot water.

d. Clean water side of the cooler as follows:

(1) Plug oil inlet and outlet.

(2) Immerse oil cooler in solution of one part muriatic acid and nine parts water after adding 1 lb. of oxalic acid and 0.01 gal. of pyridene to each 5 gal. of acid.

(3) Remove core when bubbling stops, normally 30 to 60 seconds after immersion.

(4) Place unit in a 5% solution of sodium carbonate. Remove when bubbling ceases and pressure, flush with clean warm water.

e. Flush inside of tubes with clean, light oil after both oil and water sides of cooler have been cleaned.

NOTE

When an engine failure occurs in which metal particles from worn or broken parts are released into the lubricating oil, replace the oil cooler core.

f. Clean all other metallic parts with cleaning solvent, Federal Specification P-D-680; dry thoroughly with compressed air.

13-14. Inspection and Repair

a. Check all parts for indications of excessive wear, cracks, or elongation of threads. Replace any damaged parts.

b. Check cooler element for leaks as follows.

(1) Clamp a plate with a rubber gasket to each end of the tube bundle.

(2) Install an air connection in one of the plates and attach air hose.

(3) Immerse assembly in water heated to 180°F and apply approximately 40 psi air pressure. If air bubbles are observed, element must be repaired or replaced.

(4) Upon completion of leak check dry element with compressed air.

c. Repair damaged tubes in the cooler element as described below:

- (1) Insert a smaller OD tube inside damaged tube.
- (2) Cut and flare ends and solder securely. Do not burn tubes or header material with torch.

NOTE

If more than 15% of element tubes are defective, element cannot be repaired.

d. Replace all preformed packing and gaskets removed during disassembly and removal.

13-15. Reassembly and Installation

a. Refer to figure 13-3 and assemble oil cooler in the following manner:

(1) Install bushing (24), drain cock (23), and plug (22) into housing (21).

(2) Lubricate and place new preformed packing (20) in groove of housing (21). Ensure that packing is not twisted and is free of cuts or nicks.

(3) Push element (19) carefully into housing (21). Align index marks on housing and element.

(4) Place retainer (18) and new gasket (17) on housing spacer (16). Push spacer (16) over element carefully and mate with housing (21). Secure with washers (15) and screws (14).

(5) Assemble plunger (13), spring (12), shim (11), and cap (10) to cover (7). Install plug (9).

(6) Assemble gasket (8) and cover assembly (7) to housing spacer (16). Secure with washers (6) and screws (5).

(7) Place assembly on a flat plate with inlet and outlet flat on top of plate. Both ends must be on the same plane; torque screws to 30—35 ft-lb (41—47 N·m).

b. Install lubricating oil filter as follows:

(1) Install new gaskets (4) and (3) and position oil cooler to right bank water header plate.

(2) Install washers (2) and screws (1). Tighten screws to 30—35 ft-lb torque (41—47 N·m).

Section IV. WATER PUMP

13-16. Description

The water pump is a centrifugal pump which circulates water around the cylinder liners, through the cylinder heads, and around injector sleeves. The pump is mounted on the front of the engine and belt driven from the crankshaft.

13-17. Removal and Disassembly

a. Refer to figure 13-4 and TM 5-3810-295-12 and remove water pump as described in the following:

(1) Remove radiator cap and drain the cooling

system.

(2) Loosen and remove water pump belts.

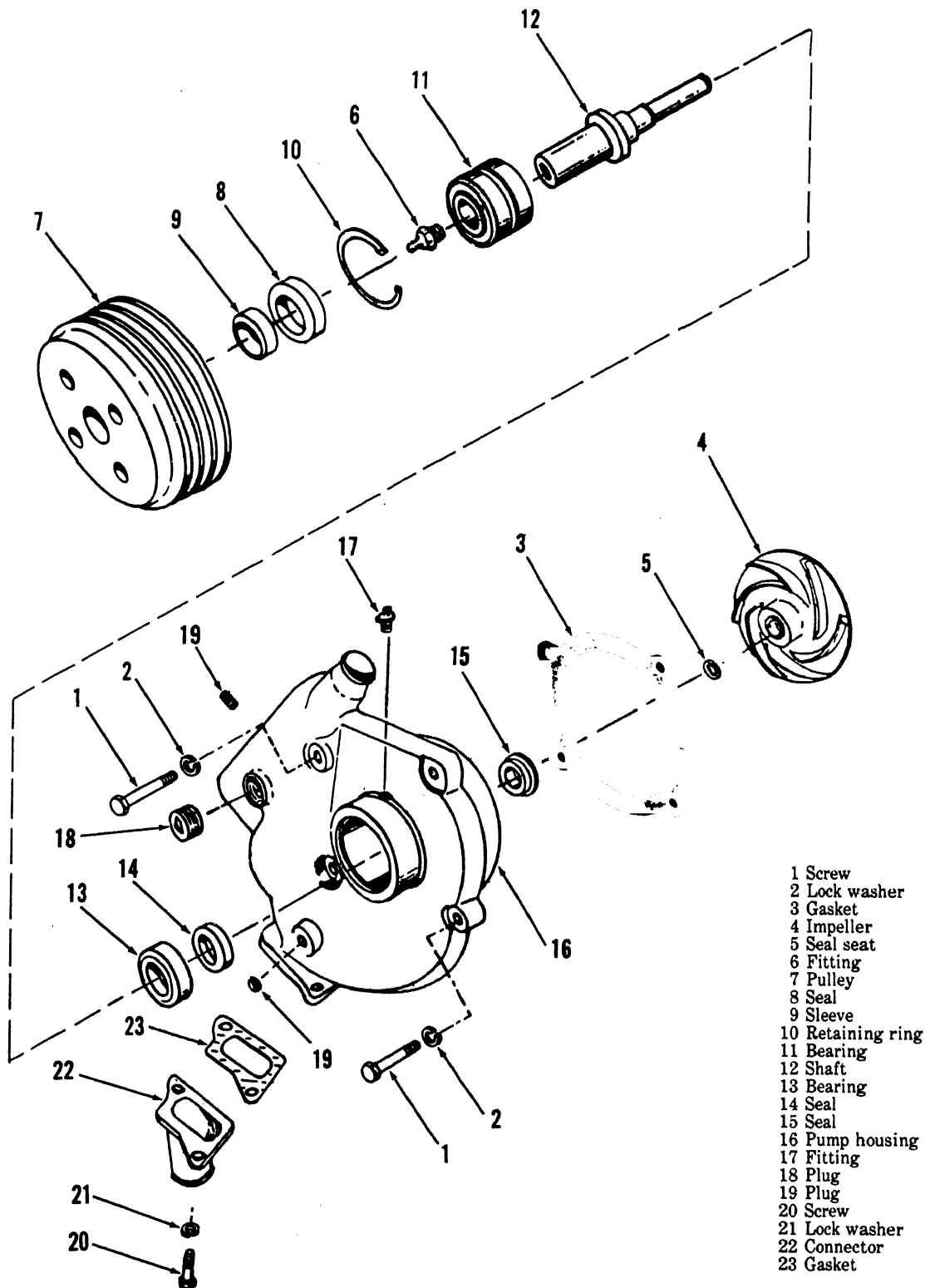
(3) Loosen hose clamps and remove hoses from water pump assembly.

(4) Remove screws (1) and lock washers (2). Lift pump from engine block.

(5) Remove gasket (3) and scrape all gasket material from mating surfaces.

b. Disassemble the water pump as follows:

(1) Pull impeller (4) from pump shaft (12) using a suitable puller.



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Figure 13-4. Water pump—exploded view.

(2) Remove seal seat (5) from impeller (4). Remove fitting (6) from impeller shaft (12).

(3) Pull pulley (7) from pump shaft. Remove oil seal (8) and sleeve (9) from pulley (7).

(4) With a pair of snap ring pliers remove retaining ring (10) from pump housing (16).

(5) Support housing (16) and press shaft (12) on impeller end. Remove bearing (11), shaft (12), bearing (13) and seal (14) from housing (16) as an assembly.

(6) Remove bearing (11), bearing (13) and seal (14) from shaft (12).

(7) Disassemble housing (16) as required by removing fitting (17) and plugs (18) and (19). Remove screws (20), and lock washers (21). Lift connector (22) from housing (16). Remove gasket (23). Clean all gasket material from connector and housing.

13-18. Cleaning

a. Clean all parts in cleaning solvent, Federal Specification P-D-680, or equivalent.

b. With a non-metallic tool remove all hardened grease or dirt.

13-19. Inspection and Repair

a. Inspect all bearings for rough or worn races. If any defects are noted, replace.

b. Check impeller for cracks or corrosion. Replace if impeller is damaged.

c. Measure impeller bore and shaft outside diameter. A minimum of 0.0015-inch press-fit between shaft and impeller is required, replace if necessary.

d. Replace all seals and gaskets removed in disassembly procedures.

13-20. Reassembly and Installation

a. Refer to figure 13-4 and reassemble water pump assembly as follows:

(1) Install new gasket (23) and connector (22) on housing (16). Secure with washers (21) and screws (20).

(2) Assemble plugs (19) and (18) and fitting (17) into the pump housing.

(3) Tightly coat outside of seal (15) with sealing compound, loctite, or equivalent. Install seal (15) in pump housing with stub face toward impeller end. Do not press seal below face.

(4) Install seal (14) and bearing (13) on shaft (12). Press shaft (12), with seal and bearing installed, into bore of pump housing (16).

(5) Press bearing (11) on pulley end of shaft, until bearing outer race seats in the pump housing.

(6) Install retaining ring (10) in pump housing to secure shaft bearings in place.

(7) Press new seal (8) into pump housing until seal seats on shoulder in pump housing.

(8) Support shaft on impeller end and place fixed sleeve (9) on shaft and press until it seats against bearing race. Install pulley (7) on shaft.

(9) Install grease fitting (6) to end of shaft and fill cavity of bore 60—70 percent full of grease.

(10) Lubricate the inside diameter of seat (5) with a light coat of water soluble lubricant. Slide the seat over the water pump shaft until the polished side bottoms against the pump seal.

(11) Support the pump assembly on the pulley end of the shaft and press impeller (4) on shaft. A 0.010—0.020-inch clearance must be maintained between the impeller vanes and pump housing.

b. Install pump assembly to the cylinder block as described:

(1) Rotate pulley to check for free turning motion.

(2) Install a new gasket (3) on the pump assembly. Place pump assembly on cylinder block and secure with washers (2) and screws (1). Torque screws to 30—35 ft-lb (41—47 N · m).

(3) Install hoses to water pump assembly. Tighten all hose clamps.

(4) Install and tighten water pump belts.

(5) Close drain cock and refill the cooling system. Start the engine and check for leaks.

Section V. FUEL PUMP AND SHUTDOWN VALVE

13-21. Description

The fuel pump is a "pressure time" type made up of three main units. The gear pump draws fuel from the supply tank and forces it through the pump filter screen to the governor. The governor controls the flow of the fuel from the gear pump, as well as the maximum and idle engine speeds. The throttle provides a manual control of fuel flow to the injectors under all conditions in the operating range.

13-22. Removal and Disassembly

a. Refer to figure 13-5 and remove the fuel pump as-

sembly as follows:

(1) Remove mounting screws (1) and (2), washers (3) and lock washers (4). Lift off fuel pump.

(2) Remove ratchet support (5), coupling (6) and gasket (7).

b. Refer to figure 13-6 and remove the shutdown valve as described in the following steps:

(1) Remove mounting screws (1), washers (2) and lock washers (3). Remove shutdown valve from the fuel pump assembly.

(2) Remove preformed packing (4) and discard.

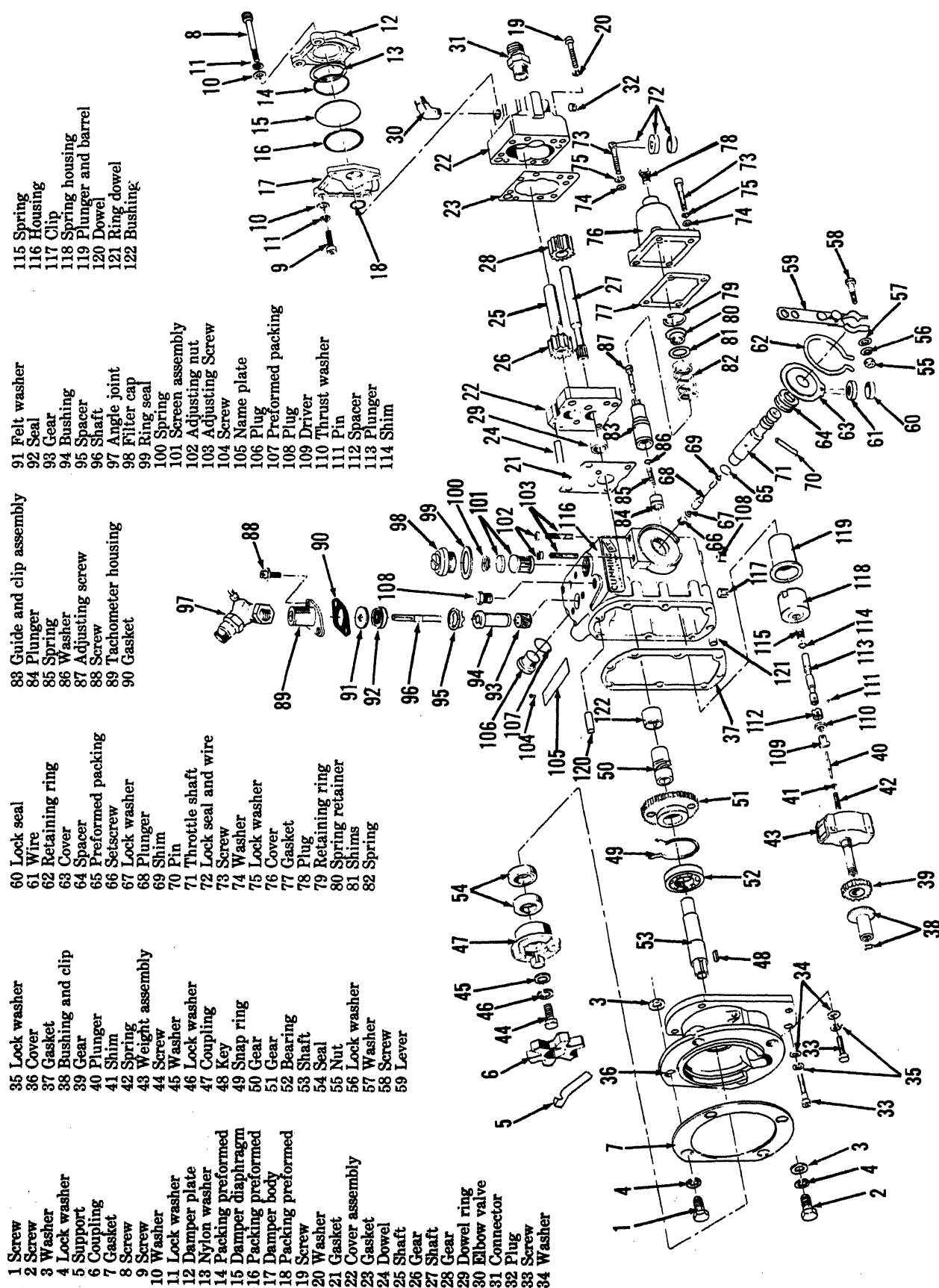
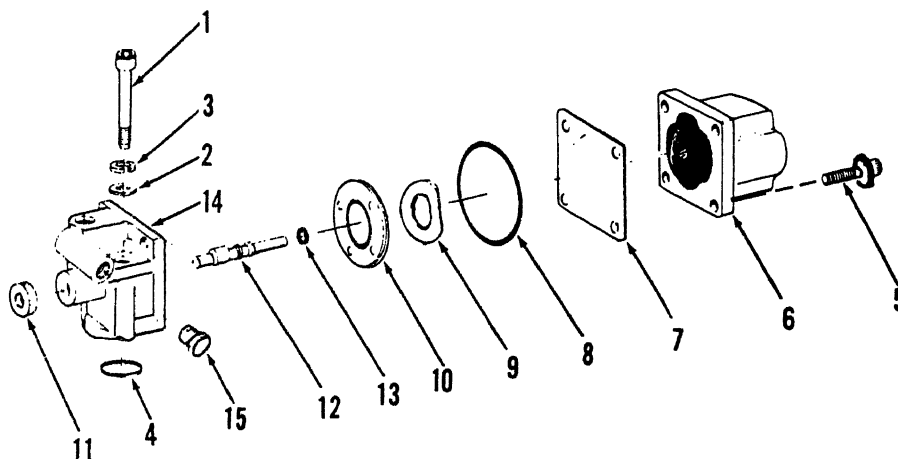


Figure 13-5. Fuel pump—exploded view.

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TA033244

1 Screw
2 Washer
3 Lock washer
4 Packing preformed
5 Screw

6 Coil assembly
7 Shield
8 Preformed packing
9 Spring washer
10 Plate-type valve

11 Knob
12 Shaft
13 Performed packing
14 Housing
15 Plug

Figure 13-6. Shutdown valve—exploded view.

c. Disassemble the shutdown valve in the following method. Refer to figure 13-6.

(1) Remove screws (5) and separate coil assembly (6) from valve housing (14).

(2) Remove shield (7) and packing (8). Discard packing. Remove spring washer (9) and plate-type valve (10).

(3) Remove override knob (11), and unscrew override shaft (12) from the coil end. Discard shaft (12) and packing (13).

(4) Remove plug (15) from housing (14).

d. Refer to figure 13-5 and disassemble the fuel pump assembly as follows:

(1) Remove screws (8) and (9), washers (10) and lockwashers (11). Remove damper assembly from fuel pump.

(2) Separate damper plate (12) and damper body (17). Remove and discard nylon washer (13) and preformed packing (14) and (16). Remove diaphragm (15) and store in a clean area until reassembly.

(3) Remove preformed packing (18) from housing (17) and discard.

(4) Remove screws (19) and washers (20). Remove gear pump assembly from fuel pump, by tapping sides with a soft hammer to loosen from dowel. Remove gasket (21) and discard.

(5) With a flat end punch, drive against dowels to separate cover assembly (22). Remove and discard gasket (23). Remove dowel (24) from cover (22).

(6) Lift shaft (25), gear (26), shaft (27), gear and ring dowel (29) from cover assembly (22).

(7) Remove elbow valve (30), connector (31) and plug (32) from cover assembly (22).

(8) Remove screws (33), washers (34) and lock washers (35). Tap edge of drive cover (36) lightly with a soft headed hammer to loosen and remove from main housing. Remove gasket (37) and discard.

CAUTION

Never use a steel hammer on aluminum, or on a finished surface, it can cause extensive damage.

(9) Remove governor weight carrier assembly. Check shaft (43) in its bushing (38) for excessive wear prior to removing bushing (38).

(10) Remove clip and bushing (38) and gear (39) from shaft of governor weight assembly (43).

(11) Remove plunger (40), shims (41) and spring (42) from the governor weight assembly (43).

(12) Remove screw (44), washer (45) and lockwasher (46) and remove coupling (47) and key (48) from shaft (53).

(13) Using hose clamp pliers remove snap ring (49). Press drive gear assembly from front cover and remove gear (50), gear (51) and bearing (52) from shaft (53).

(14) Press drive shaft seals (54) out of cover (36).

(15) Remove nut (55), lockwasher (56), washer (57) and screw (58) from throttle lever (59). Remove lever

(59) from throttle shaft (71).

(16) Remove lock seal (60) and wire (61). Compress retaining ring (62) and remove. Pull throttle assembly from pump.

NOTE

The throttle shaft is a select fit in its sleeve and sizes are identified by color code. Shaft must be handled with care.

(17) Remove throttle cover (63), spacers (64) and preformed packing (65). Discard packing. Remove setscrew (66) and lockwasher (67) from shaft (71). Remove plunger (68) and shims (69). Pull pin (70) from throttle shaft (71).

(18) Remove lock seal and wire (72) from screw (73). Remove screw (73), washer (74) and lockwasher (75). Lift off cover (76) from main housing. Remove gasket (77) and discard.

(19) Using snap ring pliers remove retaining ring (79). Remove retainer (80), shims (81) and spring (82). Pull guide and clip assembly (83). Remove plunger (84), spring (85) and washer (86) from the guide and clip assembly. Remove adjusting screw (87).

(20) Remove screws (88) and lift tachometer housing (89) from main housing. Remove gasket (90) and discard.

(21) Drive tachometer assembly from the main housing, using a brass punch and hammer.

(22) Remove felt washer (91) and seal (92) from shaft (96) and discard. Remove gear (93), bushing (94) and spacer (95) from shaft (96). Disassemble angle joint (97) and housing (89).

(23) Screw off filter cap (98) and remove seal (99), spring (100) and screen assembly (101) from the main housing.

(24) Remove adjusting nuts (102) and adjusting screws (103) from main housing.

(25) Remove screws (104) and nameplate (105). Remove plug (106) and preformed packing (107). Discard preformed packing. Remove plug (108) from main housing (116).

(26) Remove driver (109) and washer (110) from plunger (113). Remove pin (111), spacer (112), plunger (113), shims (114) and spring (115) from housing (118).

(27) Remove pin (117) and housing (118) from governor barrel (119) if required.

(28) Heat main housing (116) if it is necessary to remove barrel (119). See paragraph 13-24i.

(29) Remove dowel (120), ring dowel (121) and bushing (122) from housing (116) if required.

13-23. Cleaning

a. Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent. Dry completely with compressed air.

b. Clean filter screen and retainer by soaking in fuel oil and dry with compressed air.

c. Wipe coil assembly (6, fig. 13-6) with a clean lint-

free cloth. Do not wet with the cleaning solvent.

13-24. Inspection and Repair

a. Oil seals removed from the pump body must be replaced. Replace all gaskets and packing.

b. Check all parts for wear or excessive scoring, replace any defective parts.

c. Inspect filter screen for holes or imbedded metal particles in mesh. Replace screen if damaged.

d. Check pump gear teeth for scoring, chipping, cracks or wear; discard if damaged. Check pump gear shaft bearing surface for wear or scoring. Replace shaft if bearing surface is worn smaller than 0.4998-inch diameter.

e. Check gear width. Width must be 0.7483—0.7486 inch. Gear pocket depth in pump body and cover shall be 0.7478—0.7483 inch. Replace gears if these measurements are not met.

f. Check shaft bore in pump body and cover. Bore shall have an ID of 0.5013—0.5016 inch.

g. Inspect shut-down valve and valve seat for wear, bonding failure or corrosion. Replace if damaged. Valve seat shall have a minimum seat 0.015 inch wide.

CAUTION

Starting switch must be in the OFF position when checking coil.

h. Using an Ohmmeter check coil assembly resistance, replace if resistance is not 28.0—30.0 Ohms.

i. Check governor weight shaft bushing in the front cover assembly. If bushing ID is larger than 0.054 inch, replace.

j. The mating surfaces of the pump body and cover must fit tightly together. Check for scratches or slight damage which may result in pressure leaks. Check for wear at areas contacted by gears and shafts. Replace the cover and/or body if necessary.

k. Check governor barrel and plunger for wear. If worn, replace governor plunger with a new plunger of same class size as etched on face of governor barrel.

NOTE

Due to hardness of governor barrel sleeve, it wears very little. If worn excessively, or if plunger shows signs of scoring, barrel must be replaced.

13-25. Reassembly and Installation

a. Refer to figure 13-6 and reassemble the shutdown valve as follows:

(1) Install plug (15) into housing (14). Install new packing (13) on new shaft (12) and coat with lubricant.

(2) Screw shaft (12) into housing (14) until it is 0.118 inch below housing face. Without moving shaft, press on knob (11) until it contacts housing (14) which will act as a stop.

(3) Place valve (10) into housing (14) with the rubber side toward the housing.

(4) Place spring washer (9) on valve with the con-

cave side up and piloted around valve locator.

(5) Lubricate packing (8) and press into housing groove. Place shield (7) and coil (6) on the housing and tighten screws (5) to 15–20 in-lb (20–27 N·m) torque.

b. Refer to figure 13-5 and assemble the fuel pump in the following manner.

(1) If bushing (122) was removed, apply a thin coat of high pressure lubricant to a new bushing and press it into housing (116), flush with housing bore. Ream bushing to 0.7495–0.7505 inch.

(2) Install new dowels (121) and (120) if removed.

(3) If governor barrel and bushing (119) have been removed, install new barrel and bushing as follows:

(a) Locate new barrel in housing (116). Scribe a center line on barrel and housing, lining up the fuel passages so fuel flow will not be restricted.

(b) Heat housing to 300°F. and coat new barrel with high pressure lubricant. Drop spring pack housing (118) in place.

(c) Place governor barrel in housing bore with chamfered end first and location pin hole on bottom side. Lining up scribe marks press barrel in housing until it bottoms against spring pack housing.

(d) Select a plunger two sizes smaller than the largest plunger that will enter the barrel. Plunger must drop into bore of its own weight. Remark governor barrel with class size of plunger used. See table 13-1 for class sizes and color code.

Table 13-1 Plunger Size and Color Code

Code	Size	Part No.
Red	0	182530
Blue	1	182531
Green	2	182532
Yellow	3	182533
Orange	4	182534
Black	5	182535
Gray	6	182536
Purple	7	182537

(e) Install pin dowel (117) into bottom of barrel with slot of pin to front of housing.

(4) Press stop sleeve (112) on plunger (113) with notched end going on plunger toward governor barrel.

NOTE

The chamfered side of thrust washer (110) must be installed next to driver (109). There must be 0.002–0.005 inch clearance between washer face and driver so washer will "float".

(5) Place driver (109) through thrust washer (110) and drive into plunger (113). Drive must have interference fit in plunger.

NOTE

Protect plunger finish when installing pin (111) by placing plunger on copper jawed vise or V-block.

(6) Drive retainer pin (111) through the plunger

and plunger driver.

(7) Install spring (115) and install required number of shims (114). Place the small end of spring (115) on the shoulder end of plunger (113) with a twisting motion to avoid distorting the spring.

(8) Lubricate plunger (113) with engine oil and install into barrel. Size of barrel and plunger must correspond.

(9) Install plug (108), packing (107) and plug (106) into housing (116).

(10) Assemble nameplate (105) to housing with screws (104).

(11) Install adjusting screws (103) and adjusting screw lock nuts (102).

(12) Place filter screen (101), spring (100), ring seal (99) and filter cap (98) into housing. Torque cap to 25–30 ft-lb (34–41 N·m).

(13) Place bushing (94) on shaft (96) with chamfered end of bushing toward gear end. Press gear (93) on shaft (96) until it is flush with end of shaft. Gear must turn freely on shaft with a maximum clearance between gear and bushing of 0.005 inch.

(14) Align oil groove in top of bushing (94) with fuel pump drive shaft. Press bushing (94), shaft (96) and gear assembly (93) into housing until bushing bottoms.

CAUTION

Do not overpress spacer. It can be flattened, eliminating its effectiveness.

(15) Install spacer (95) on top of bushing with slotted edge down. Install new seal (92) with spring side down. Spacer must bottom on bushing.

(16) Cover top of seal (92) with a thin coat of lubricating oil. Install new felt washer (91) with white side up. Install new gasket (90) and place housing (89) on housing (116). Secure with screws (88). Screw angle joint (97) on housing (89).

(17) Place idler screw (87) into guide (83). Assemble washer (86), spring (85) and plunger (84) over screw point inside of guide. Slide guide (83) into housing.

(18) Install spring (82), shim (81) and retainer (80) on guide (83). Secure in place with ring (79). Install new gasket (77) and place cover (76) on housing. Secure with washers (74), lockwashers (75) and screws (73). Install lock seal and wire (72) on screws (73). Install plug (78) in cover (76).

(19) Lubricate and install new preformed packing (65) on throttle shaft (71). Install shims (69) and plunger (68). Plunger shall be flush with the fuel passage leaving it completely open. Place lockwasher (67) and screw (66) on plunger. Torque to 40–45 in-lb (54–61 N·m).

(20) Install spacers (64) over shaft (71). Insert shaft (71) in cover (63) so the open side of pin (70) is down, lubricate with fuel oil.

NOTE

Counterbored port on throttle shaft must go down.

(21) Install ring (62) and lock in groove in front of cover (63). Install lock seal (60) and wire (61).

(22) Install lever (59) on shaft and install screw (58), washer (57), lock washer (56) and nut (55).

(23) Press oil seals (54) into drive cover (36). One seal pressed with lip toward the outside of pump, and the second pressed in with sealing lip toward the inside of the pump. Seals must be spaced so the "telltale" hole is not covered.

(24) Press bearing (52) and gears (51) and (50) on drive shaft (53). Place ring (49) between bearing (52) and gear (51). Press main shaft assembly into front cover through the seals. Secure ring (49) in cover groove.

(25) Install key (48) and press coupling (47) on shaft. Install washer (45), lock washer (46) and screw (44). Hold coupling or shaft in a copper jawed vise while tightening.

(26) Press gear (39) and bushing (38) on shaft of governor weight assembly (43). Secure with ring (38). Coat bushing (38) with high pressure lubricant and press assembly into front cover until bushing seats against housing. Mesh gears to avoid gear tooth damage. Rotate weight assembly, with weights opened out, to be sure it will turn completely in housing.

(27) If required install shims (41) on plunger (40). Place spring (42) and plunger (40) into bore of governor weight carrier shaft. Plunger must protrude above gasket face of front cover.

NOTE

Weight assist plunger (40) must always be assembled with the smallest end to the weights.

This prevents the weights from sticking.

(28) Place a new gasket (37) over the pump housing dowel pins. Install cover (36) to housing (116). Hold the governor weights in to hold the assist plunger while assembling the cover to housing.

(29) Position plunger drive tang horizontally and weight carrier horizontally.

(30) Install washers (34), lock washers (35) and screws (33). Torque screws (33) 9—11 ft-lb (12—15 N·m). Rotate drive shaft to insure tachometer gear is properly meshed.

(31) Install plug (32), connector (31) and elbow valve (30) on cover assembly (22). Install ring dowel (29) in cover assembly (22).

(32) Press gear (28) on shaft (27) and gear (26) on shaft (25). Lubricate and slide shafts (25) and (27) into cover assembly (22).

(33) Install new gasket (23) and mate the cover assembly (22). Locating notches must be aligned.

NOTE

When a right hand rotation pump is being assembled, place the driven gear shaft of the gear pump in the pocket nearest the locating notches. Place the driving gear shaft in the other pocket. Always locate the ring dowel around the driving gear shaft.

(34) Install new gasket (21) and place gear pump on housing. Locate notch for right hand or left hand rotation.

NOTE

For right rotation locate notch to upper right hand corner (looking from behind the fuel pump); for left hand rotation locate the notch to bottom left hand corner.

(35) Install washer (20) and screws (19) torque in equal increments to 11—13 ft-lb (15—18 N·m).

(36) Install new packing (14) and (16). Place nylon washer (13) on damper plate (12). Coat the damper diaphragm (15) with a good grade of 10 wt. or 20 wt. oil and lay in body (17). Install new packing (18) in body (17).

(37) Assemble plate (12) to body (17) and install washers (10), lock washers (11) and screws (9) and (8). Secure damper to the gear pump. Torque screws to 11—13 ft-lb (15—18 N·m).

c. Refer to figure 13-6 and install the shutdown valve to the fuel pump as follows:

(1) Install a new packing (4) to fuel pump.

(2) Install washer (2), lock washer (3) and screws (5). Secure shutdown valve to pump housing.

d. Refer to figure 13-5 and install fuel pump as follows:

(1) Install new gasket (7) to the drive cover. Install coupling (6) and ratchet support (5).

(2) Mount fuel pump assembly and secure with washers (3), lock washers (4) and screws (1) and (2).

Section VI. AIR COMPRESSOR AND REAR BEARING SUPPORT

13-26. Description

The compact air compressor operates continuously while the engine is running. Actual air compression, however, is controlled by the air governor. The air governor, in conjunction with the unloader valve in the compressor cylinder head, starts or stops the compression of air by loading or unloading the compressor

when the air reservoir pressure reaches a predetermined figure.

The two-piece cylinder head is a die cast aluminum construction with integral coring for increased cooling. The two-piece head is made up of a head and a head cover. A machined bore for an unloader body is provided in the head cover. For ease of air and water pip-

ing, both the head and the head cover may each be rotated a full 360° in 90° increments, the unloader body on the air compressor may also be rotated 360° in 90° increments.

The connecting rod in a one-piece unit, with the bearings integral with the connecting rod. The support and thrust bearings are integral with the support.

13-27. Removal and Disassembly

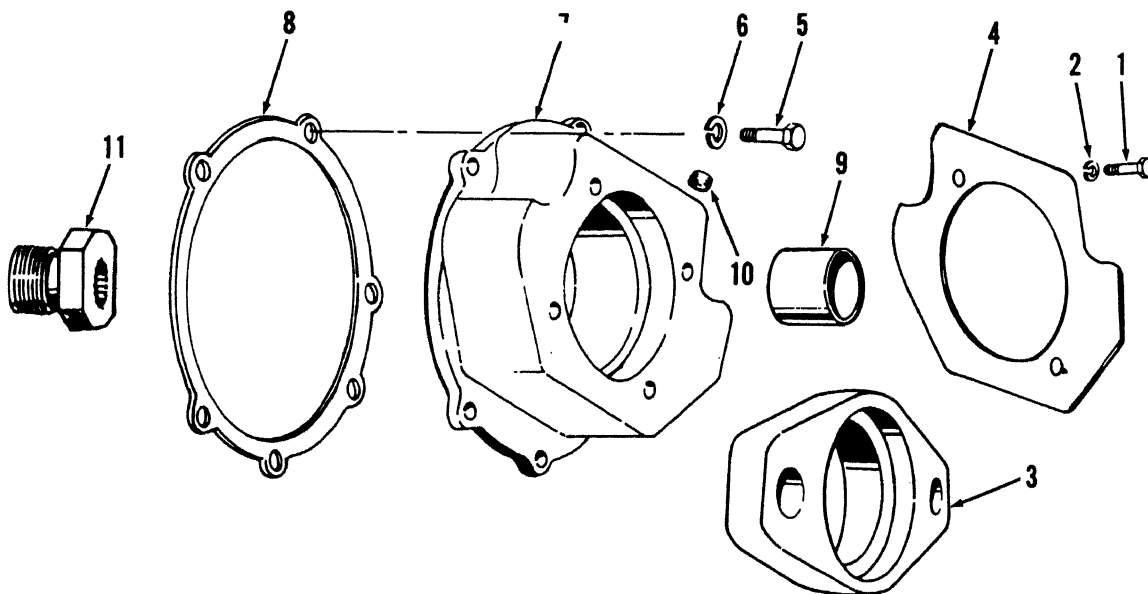
a. Refer to figure 13-7 and remove the rear bearing support as follows.

(1) Remove capscrews (1) and lock washers (2). Remove adapter (3) and gasket (4) from support (7). Discard gasket (4).

(2) Remove capscrews (5) and lock washers (6). Remove support (7) and gasket (8) from air compressor. Discard gasket (8).

(3) Remove bushing (9) and pipe plug (10) from support (7).

(4) Remove mounting adapter (11).



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- 1 Capscrew
- 2 Lock washer
- 3 Pump adapter
- 4 Gasket
- 5 Capscrew
- 6 Lock washer
- 7 Support
- 8 Gasket
- 9 Bushing
- 10 Pipe plug
- 11 Mounting adapter

Figure 13-7. Rear bearing support—exploded view.

b. Refer to figure 13-8 and remove the air compressor as follows.

(1) Drain radiator and air reservoir.

(2) Remove tubing (1) and (2), bushing (3), connector (4), elbow (5), bushing (6) and connector (7).

(3) Remove capscrew (8), lockwasher (9) nut (10), and clamp (11).

(4) Remove clamp (12) and hose (13).

(5) Remove capscrews (14) and (15), lock washers

(16), and washers (17). Lift outlet elbow (18) off and remove pipe plug (19). Pull gasket (20) and discard.

(6) Remove capscrews (21) and (22), lock washers (23) and washers (24). Lift off spacer (25) from bracket (26). Remove bracket (26).

c. Refer to figure 13-8 and disassemble the air compressor as follows.

(1) Remove capscrews (27), lock washers (28) and washers (29).

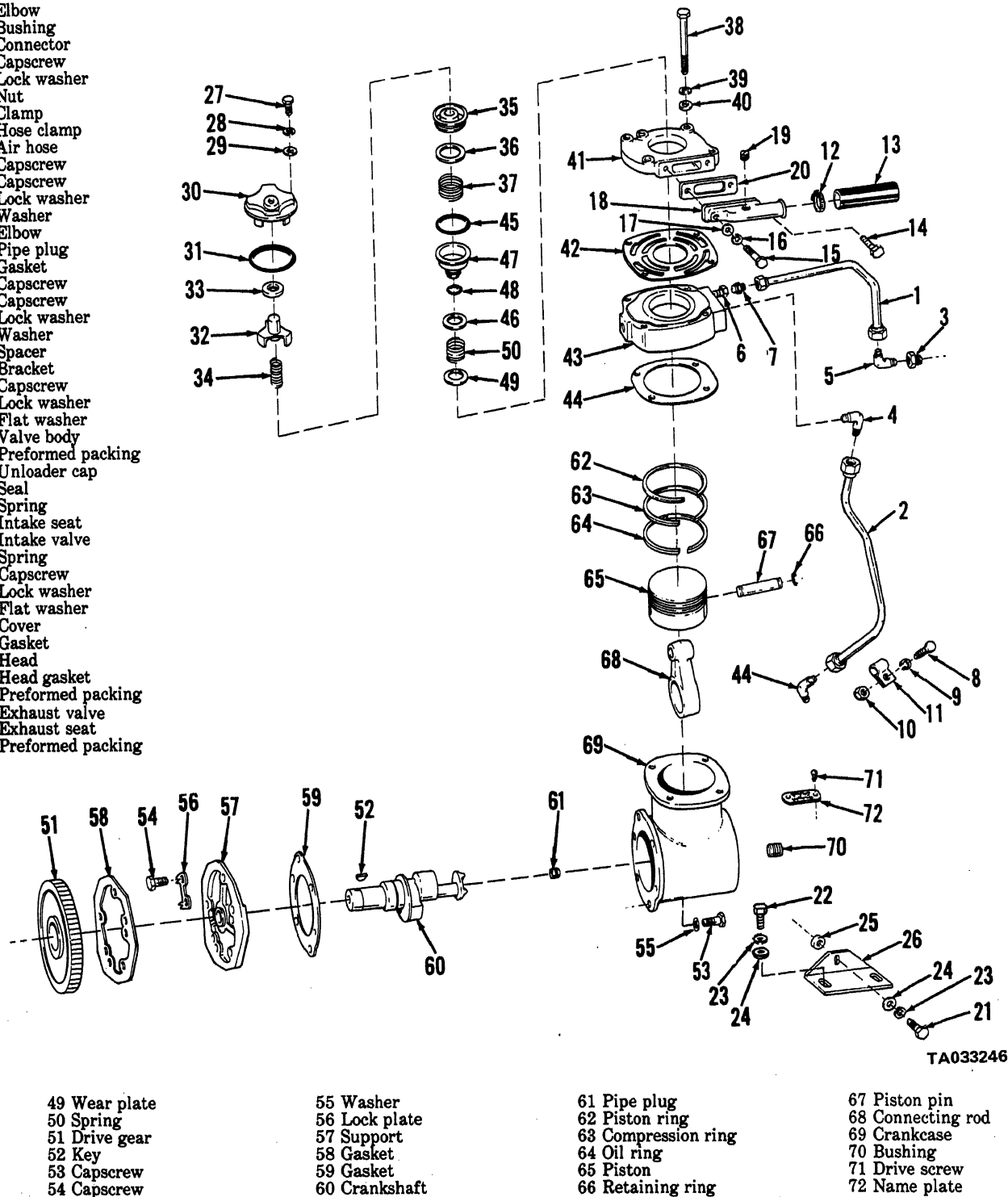
(2) Screw a 4- or 5-inch pipe into the inlet boss and carefully work unloader valve assembly from cylinder head.

(3) Remove preformed packing (31) from body (30)

and discard. Remove cap (32) and seal (33) from body (30).

(4) Remove spring (34) from intake valve seat and discard.

- 1 Water tube
- 2 Water tube
- 3 Bushing
- 4 Connector
- 5 Elbow
- 6 Bushing
- 7 Connector
- 8 Capscrew
- 9 Lock washer
- 10 Nut
- 11 Clamp
- 12 Hose clamp
- 13 Air hose
- 14 Capscrew
- 15 Capscrew
- 16 Lock washer
- 17 Washer
- 18 Elbow
- 19 Pipe plug
- 20 Gasket
- 21 Capscrew
- 22 Capscrew
- 23 Lock washer
- 24 Washer
- 25 Spacer
- 26 Bracket
- 27 Capscrew
- 28 Lock washer
- 29 Flat washer
- 30 Valve body
- 31 Preformed packing
- 32 Unloader cap
- 33 Seal
- 34 Spring
- 35 Intake seat
- 36 Intake valve
- 37 Spring
- 38 Capscrew
- 39 Lock washer
- 40 Flat washer
- 41 Cover
- 42 Gasket
- 43 Head
- 44 Head gasket
- 45 Preformed packing
- 46 Exhaust valve
- 47 Exhaust seat
- 48 Preformed packing



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Figure 13-8. Air compressor—exploded view.

(5) Using a large screwdriver inserted into slots of intake valve seat, rotate seat (35) from cylinder head and discard.

(6) Remove intake valve (36) and spring (37) from head (43); discard spring.

(7) Remove capscrews (38), lock washers (39), and washers (40). Lift cover (41), gasket (42), head (43), and gasket (44) from crankcase (69); discard gaskets.

(8) Press exhaust valve assembly from under side of head with thumb pressure. Remove preformed packing (45), from exhaust seat (47).

(9) Remove exhaust valve (46) from exhaust seat (47). Remove and discard preformed packing (48). Remove wear plate (49) and spring (50) from head (43).

(10) Using a suitable gear puller, remove drive gear (51). Remove key (52).

(11) Remove capscrews (53) and (54), washers (55), and lock plates (56). Remove support (57) and gaskets (58) and (59). Discard gaskets.

CAUTION

Do not damage rod bearing (68) when removing crankshaft (60).

(12) Remove crankshaft (60) by rotating while pulling from crankcase (69). Remove plug (61).

NOTE

Clean carbon from worn ridge at top of crankcase bore.

(13) Push piston and rod assembly out top of crankcase and remove piston rings (62), (63) and (64) from piston (65). Discard piston ring (62).

NOTE

Discard all rings if worn excessively.

(14) Remove piston pin retaining rings (66). Place piston in hot water to expand piston pin bore.

CAUTION

Do not drive pin from piston, as this will distort piston (65).

(15) Push piston pin (67) from piston (65). Remove connecting rod (68).

NOTE

Parts should be placed in a pan or rack to prevent damage.

(16) Remove bushing (70) from crankcase (69). If required remove drive screws (71) and name plate (72).

13-28. Cleaning

a. Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent. Dry com-

pletely with compressed air.

b. Remove all carbon from valve cavities and all rust and scale from water cavities. Remove dirt from all cavities using compressed air.

CAUTION

Do not use a screwdriver to remove carbon and scale; this may damage the sealing surfaces.

c. Remove or drill out oil restrictive orifice.

13-29. Inspection and Repair

a. Check visually for cracks, breaks or excessive scoring in the cylinder head.

b. Check exhaust valve seat height. If height is less than 0.485 inch, discard seat.

c. Check intake valve seat height. If height is less than 0.270 inch, discard seat.

d. Apply "bluing" to exhaust and intake valve seating surfaces to check seats. Seating surfaces that are not 100% true may be lapped. Discard valve assembly if lapping will reduce seat height beyond the described wear limits.

e. If lapping is required for a good seat, follow the steps outlined.

(1) Apply "bluing" to surface of exhaust valve to be lapped and allow to dry.

(2) Apply lapping compound to exhaust valve and place valve on seat.

(3) Insert valve seat in lapping block and using a standard hand lapper and rubber suction cup, lap valve until a good seat is acquired. Valve must be flat within 0.001 inch total indicator reading.

(4) Remove all lapping compound.

f. If intake valve requires lapping proceed as follows.

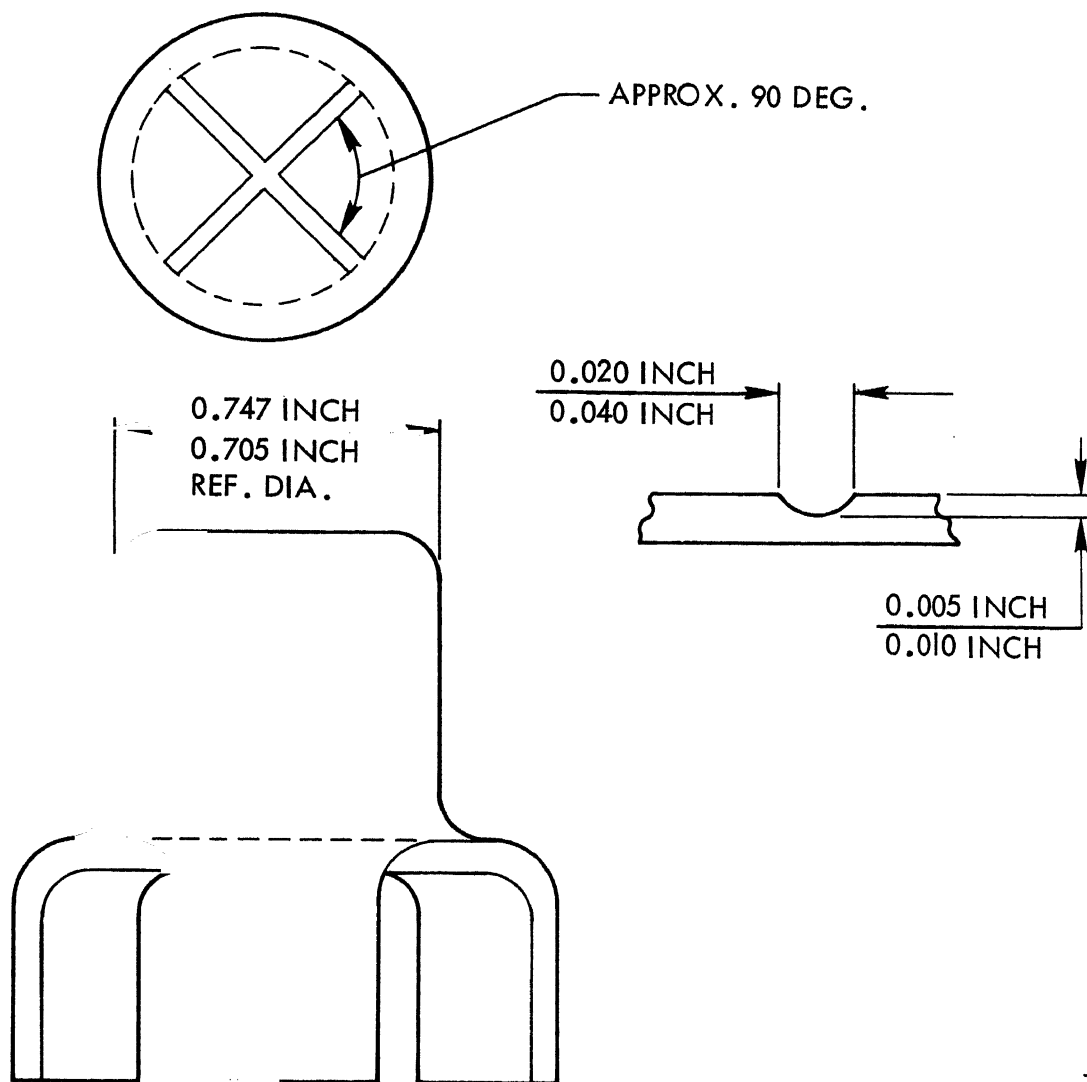
(1) Install rubber buffer in top of exhaust valve seat.

(2) Apply "bluing" to intake valve and allow to dry.

(3) Apply lapping compound to intake valve. Place valve seat on intake valve and lap until a good seat is acquired. Valve must be flat within 0.001 inch total indicator reading.

(4) Remove all lapping compound.

g. Check for scoring or excessive wear on upper part of unloader cap where packing seal seats. If top of unloader cap sticks beyond bottom of unloader body, file a cross on top of unloader cap. See figure 13-9.



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Figure 13-9. Top of unloader body.

h. Check for distortion, pitting or wear in the seating area of unloader cap:

capable of accurate measurements of spring length and load. Springs must meet the requirements given in table 13-2.

i. Test springs on a suitable spring tester that is

TABLE 13-2 Spring Data

Spring	Approx free length	No. coils	Wire dia.	Length inches	New min. LB	New max. LB	Worn limit LB.
Exhaust	0.670	3.0	0.080	0.280	8.5	10.4	8.0
Unloading	1.650	11.5	0.080	0.98	32.0	38.0	30.0
Intake	0.500	2.75	0.280	0.280	0.65	1.10	0.55

j. Check head for water leakage as follows.

(1) Assemble cylinder head cover to head using a new gasket.

(2) Assemble cylinder head to crankcase using a

new gasket. Tighten capscrews alternately to a final torque of 15—17 ft-lb (20—23 N · m).

(3) With the water outlet plugged apply water under 20—30 psi pressure through the water inlet.

Check for leaks. Discard parts as necessary.

(4) Release pressure from inlet and remove plug from water outlet. Replace water outlet fitting.

k. Check for scratches, scoring and wear of the crankshaft. Replace if wear limits of table 13-3 are not met.

TABLE 13-3 Crankshaft Wear Limits

Front support journal	Connecting rod journal	Drive support journal	Rear coupling journal
1.871 inches	1.9330 inches	1.7465 inches	1.871 inches

l. Check front support for scratches, scoring and wear. If thrust flange measurement exceeds 1.7555 inches, replace.

m. Check ID of support bearing if measurement exceeds 1.7555 inches, replace bushing.

n. Check ID of connecting rod bearings. If ID exceeds 1.9395 inches at crankshaft end or at piston pin end, connecting rod must be scrapped.

o. Check connecting rod for bend and twist. Bend must not exceed 0.002 inch or twist 0.004 inch.

p. Check gear and drive adapter for excessive wear, broken or cracked teeth and drive spline in adapter.

q. Check OD of piston pin. If OD is worn smaller than 0.6872 inch, pin should be replaced.

r. Inspect piston for scoring, cracks, wear or other damage. Check wear as follows.

(1) Measure piston wear one inch below and at right angle to the piston pin bore. If skirt diameter is less than 3.6165 inches at 70°F, discard piston.

(2) Measure piston pin bore at 70°F. If ID of bore is greater than 0.6885 inch, replace piston.

(3) Install a new ring in groove of piston. Insert a 0.004-inch feeler gauge between ring and piston groove. Compress ring in groove. If ring is below piston land surface with feeler gauge in place, wear is excessive and piston must be replaced.

s. Check piston ring gaps as follows.

(1) Using a piston head, seat one ring at a time squarely in an unworn portion of cylinder bore.

(2) Measure ring gap with a feeler gauge. Gap requirement for each ring is shown in table 13-4.

Table 13-4 Ring Gap Requirement

Ring	Min.	Max.
No. 1 Compression	0.010 inch	0.020 inch
No. 2 Compression	0.010 inch	0.020 inch
0.1 Ring	0.015 inch	0.055 inch

t. Check crankcase cylinder bore for out-of-round.

13-30. Reassembly and Installation

a. Refer to figure 13-8 and reassemble the air compressor as follows;

(1) Replace name plate (72) with drive screws (71) if required.

(2) Lubricate bushing bore in crankcase (69). Press new bushing (70) into bore flush with bore surface.

(3) Assemble piston (65) and connecting rod (68) in the following method.

(a) Heat piston (65) in hot water for 30 minutes, expanding piston pin bore.

CAUTION

Piston pin (67) must not be driven into piston pin bore. Driving piston pin into bore will distort piston (65).

(b) Install piston pin (67) through piston (65) and connecting rod (68).

(c) Secure piston pin (67) with retaining rings (66).

(4) Assemble piston rings (62, 63 and 64) on piston (65). Install new teflon compression ring (62) in top groove with inner and outer ring 180° apart. Stagger gaps on rings (63 and 64).

CAUTION

The word "TOP" on compression rings must be up (toward crown of piston). Do not scratch piston when installing rings. Do not clamp rod in vise unless rod is protected by soft wood.

(5) Lubricate crankcase bore and piston rings. Install piston and rod assembly in crankcase (69) using a suitable ring compressor.

(6) Assemble pipe plug (61) in crankshaft (60). Lubricate journals of crankshaft (60).

CAUTION

Support crankshaft (60) with a suitable support block. Do not allow crankcase to rest on table.

(7) Install crankshaft (60) through connecting rod (68) and bushing (70).

(8) Place gasket (59) in place and slide support (57) over crankshaft. Secure with lock plate (56), washers (55) and capscrews (54) and (53). Torque capscrews alternately to 30 ft-lbs. (41 N·m).

(9) Install drive gear key (52) in crankshaft (60).

Place gasket (58) on support (57).

(10) With sleeve or pipe against shoulder of drive gear (51) press gear on crankshaft (60) until against shoulder.

(11) Refer to paragraph 13-29 *j* above (water leakage check) and install cover (41), gasket (42), head (43) and gasket (44). Secure with capscrews (38), lock washers (39) and flat washers (40) as outlined.

(12) Lubricate valve assembly with high detergent oil (Nos. 10 wt., 20 wt. or 30 wt.). Install wear plate (49) and exhaust spring (50) in head (43).

(13) Place exhaust valve (46) on exhaust seat (47); install new preformed packings (48) and (45) on exhaust seat (47).

(14) Lubricate preformed packing (45) and (48) and install exhaust valve assembly in head. Seat assembly by applying pressure with thumbs.

(15) Install new intake spring (37) with the "turned-in end" against top of exhaust seat.

CAUTION

Lapped surface of valve must be up.

(16) Insert intake valve (36) on top of intake spring (37). Insert new intake seat (35) on top of intake valve (36).

(17) Install new unloader spring (34) and seal (33) in unloader cap (32).

(18) Lubricate and assemble new preformed packing (31) on valve body (30).

(19) Lubricate the OD only with thredgard and slide unloader cap (32) into bore of unloader body (30).

(20) Lubricate body (30) and preformed packing (31) and install cap (32) over spring (34) in cylinder head. Thru legs of cap (32) must protrude into thru openings of intake seat (35).

(21) Secure with flat washers (29), lock washers (28) and capscrews (27). Torque alternately to a final torque of 8—10 ft-lb (11—14 N • m).

b. Refer to figure 13-8 and install air compressor as follows.

(1) Install bracket (26) with capscrews (22), lock washers (23) and washers (24).

(2) Install bushing (25) in bracket (26) and install air compressor, engage compressor drive gear and camshaft gear. Align timing marks on mating gears. Snug tighten capscrews (21), lock washers (23) and washers (24).

(3) Attach dial indicator gauge to gear housing and check gear backlash. Backlash must be 0.004 to 0.012 inch. If readings are out of limits, gear or gear train must be replaced.

(4) Install gasket (20) and inlet elbow (18) with capscrews (14) and (15), lock washers (16) and washers (17). Install pipe plug (19) in elbow.

(5) Install hose (13) and clamp (12). Install connectors (4) and (7) into compressor head.

(6) Install bushing (3), connector (4) elbow (5) and water tubes (1) and (2). Secure tubes with clamp (11), capscrews (8), lock washers (9) and nuts (10).

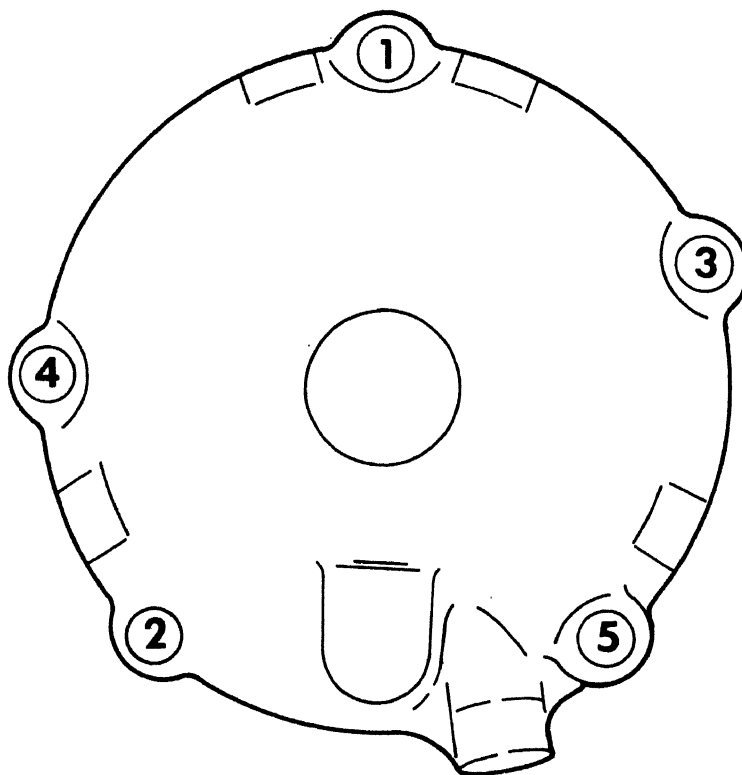
c. Refer to figure 13-7 and reassemble and install the rear bearing support as follows.

(1) Install mounting adapter (11) on compressor shaft.

(2) Install pipe plug (10) and bushing (9) in bearing support (7). Coat sealing lips with clean lubricating oil.

(3) Place gasket (8) on support (7) and slide bearing support (7) over compressor drive shaft. Position support to gear housing.

(4) Install lock washers (6) and capscrews (5). Tighten capscrews (5) in sequence shown in figure 13-10 to 15—20 ft-lb (20—27 N • m). Repeat torquing sequence, tighten to 30—35 ft-lb (41—47 N • m) torque.



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Figure 13-10. Bearing support torquing sequence.

- (5) Install new gasket (4, fig. 13-7) and adapter (3). Install lock washers (2) and capscrews (1), snug tighten only.

Section VII. FUEL TANK, LINES AND FITTINGS

13-31. Removal and Disassembly

a. Refer to figure 13-11 and disconnect fuel lines as described:

- (1) Loosen couplings (1) and (2). Remove hose (3). Remove elbows (4) and (5).
- (2) Loosen couplings (6) and remove hose (7). Remove adapter (8).
- (3) Remove elbow (9), bushing (10), pipe tee (11),

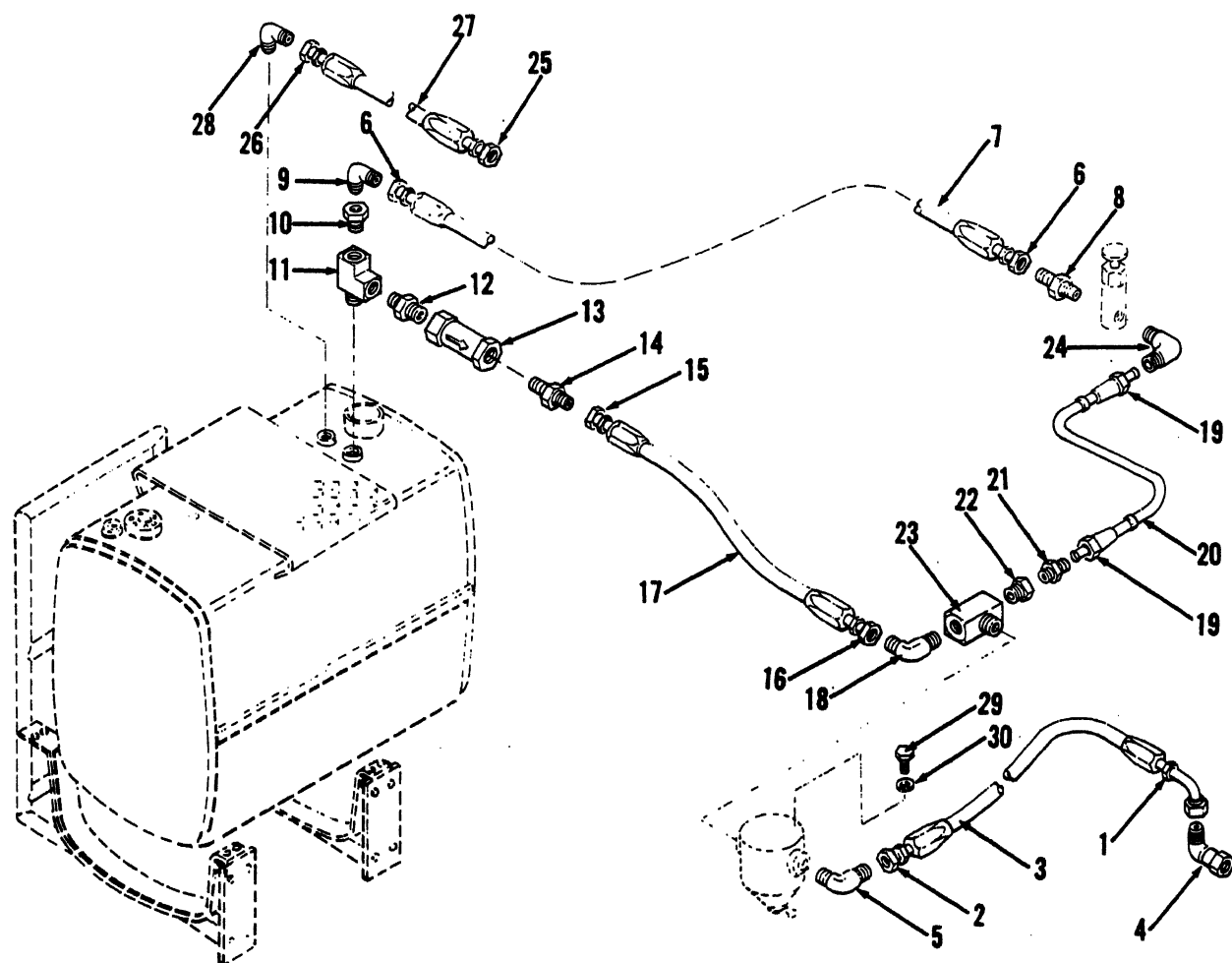
reducer (12), check valve (13), and adapter (14).

(4) Loosen couplings (15) and (16) and remove hose (17). Remove elbow (18).

(5) Loosen nuts (19) and remove tube (20). Remove adapter (21), bushing (22), pipe tee (23), and elbow (24).

(6) Loosen couplings (25) and (26) and remove hose (27). Remove elbow (28).

(7) Remove cap screw (29) and lock washer (30).



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- 1 Coupling
- 2 Coupling
- 3 Hose
- 4 Elbow
- 5 Elbow
- 6 Coupling
- 7 Hose
- 8 Adapter
- 9 Elbow
- 10 Bushing

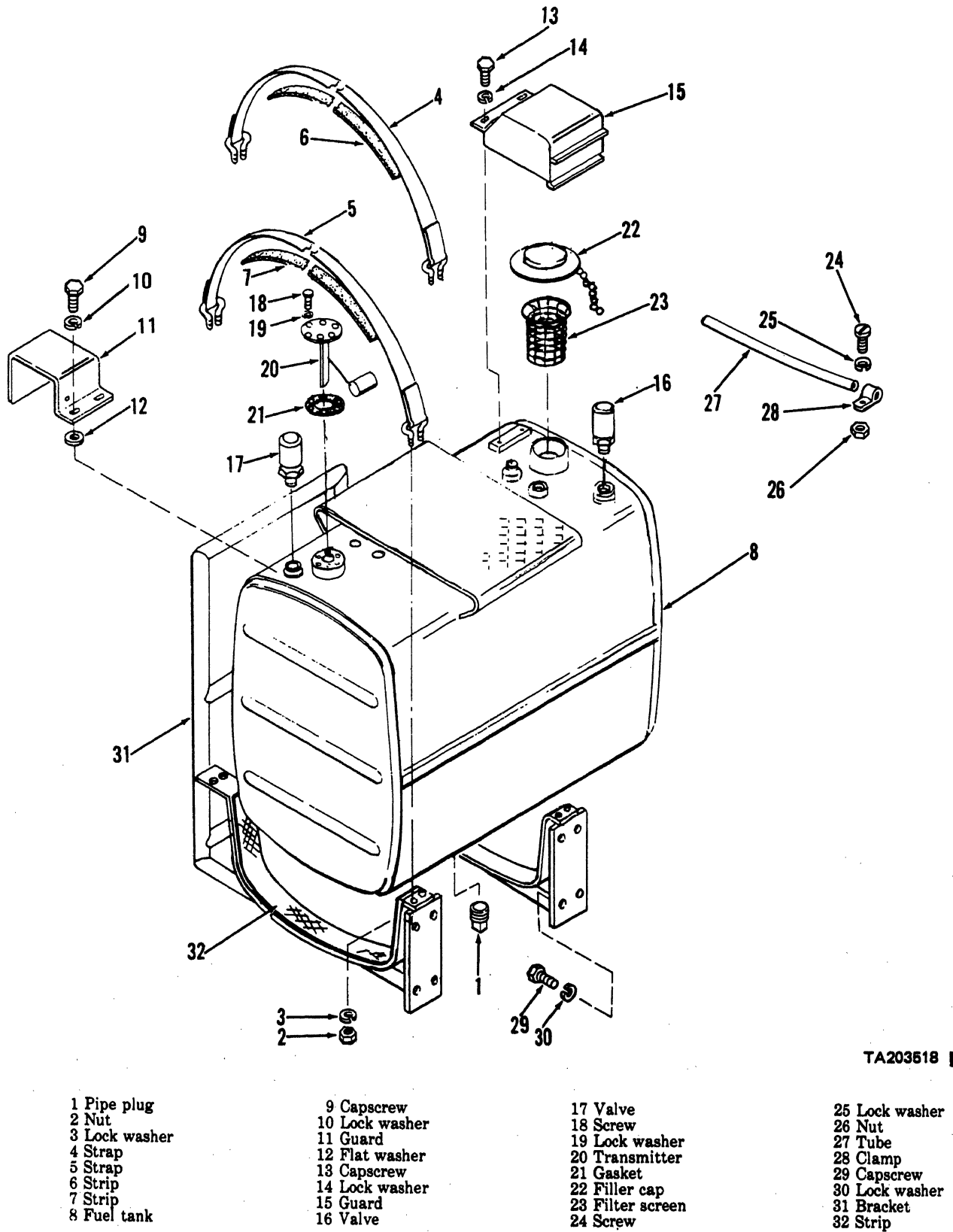
- 11 Pipe tee
- 12 Reducer
- 13 Check valve
- 14 Adapter
- 15 Coupling
- 16 Coupling
- 17 Hose
- 18 Elbow
- 19 Nut
- 20 Tube

- 21 Adapter
- 22 Bushing
- 23 Pipe tee
- 24 Elbow
- 25 Coupling
- 26 Coupling
- 27 Hose
- 28 Elbow
- 29 Cap screw
- 30 Lock washer

Figure 13-11. Fuel lines and fittings.

b. Refer to figure 13-12 and remove and disassemble the fuel tank as follows:

- (1) Drain the fuel tank by removing pipe plug (1). Disconnect and tag electrical lead on transmitter (20).



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Figure 13-12. Fuel tank—exploded view.

(2) Remove nuts (2) and lock washers (3). Lift straps (4) and (5) from bracket (31) and remove strips (6) and (7).

(3) With a suitable lifting device, remove fuel tank (8) from brackets.

(4) Remove capscrews (9), lock washers (10), guard (11) and washers (12) from the fuel tank.

(5) Remove capscrews (13), lock washers (14) and guard (15).

(6) Remove valves (16) and (17).

(7) Remove screws (18) and lock washers (19). Lift transmitter (20) out of fuel tank (8). Remove and discard gasket (21).

(8) Remove filler cap (22) and filter screen (23).

(9) Remove screw (24), lock washer (25) and nut (26). Lift tube (27) from tank (8) and remove clamp (28).

(10) Remove capscrews (29) and lock washers (30). Remove bracket (31) and lift strips (32) from bracket.

13-32. Cleaning

a. Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent. Dry completely with compressed air.

b. Clean filter screen by back flushing.

c. Discard all gaskets.

d. Remove all sludge, deposits and water.

13-33. Inspection and Repair

a. Inspect the fuel tank for cracks, breaks or leaks. If any defects are located, clean tank with live steam and weld after all fumes are removed.

WARNING

Steam clean fuel tank thoroughly before welding. Leave all openings uncovered during welding. Refer to TM 9-237 for safety precautions for welding containers that have held combustibles.

b. Inspect all parts for thread damage or defects. Replace as required.

13-34. Reassembly and Installation

a. Refer to figure 13-12 and assemble and install the fuel tank assembly as described.

(1) Install strips (32) and bracket (31). Place bracket (31) in position and secure with lock washer (30) and capscrew (29).

(2) Place clamp (28) on tube (27) and secure in place with nut (26), lock washer (25) and screw (24).

(3) Assemble filter screen (23) and filler cap (22) to fuel tank (8).

(4) Install new gasket (21). Place transmitter (20) in fuel tank and secure with lock washer (19) and screw (18).

(5) Install valves (17) and (16). Position guard (15) on tank and secure with lock washers (14) and capscrews (13).

(6) Place flat washers (12) and guard (11) on tank, secure with lock washers (10) and capscrews (9).

(7) Using a suitable lifting device, position fuel tank (8) in bracket (31).

(8) Install strips (6) and (7) on straps (4) and (5). Place straps (4) and (5) on bracket (31) and secure with lock washers (3) and nuts (2).

(9) Install pipe plug (1).

b. Refer to figure 13-11 and assemble the fuel lines and fittings as follows.

(1) Install lock washers (30) and capscrews (29).

(2) Install elbow (28) and place hose (27) in position. Tighten couplings (25) and (26).

(3) Install elbow (24), pipe tee (23), bushing (22), adapter (21), and hose (20). Tighten nuts (19).

(4) Install elbow (18) and hose (17). Tighten coupling (16).

(5) Install pipe tee (11), reducer (12), check valve (13), and adapter (14). Tighten coupling (15).

(6) Install bushing (10), elbow (9), adapter (8), and hose (7). Tighten couplings (6).

(7) Install elbows (5) and (4) and hose (3). Tighten couplings (1) and (2).

(8) Check all connections for fuel leaks.

Section VIII. REPAIR OF RADIATOR AND FAN DRIVE ASSEMBLY

13-35. Description

The radiator assembly is made up of a water cooling radiator, oil cooler, hydraulic controlled fan, and radiator shroud. Coolant is circulated from the water pump to the radiator where it is cooled, and then recirculated through the cooling system.

13-36. Removal and Disassembly

a. Remove carrier radiator as follows:

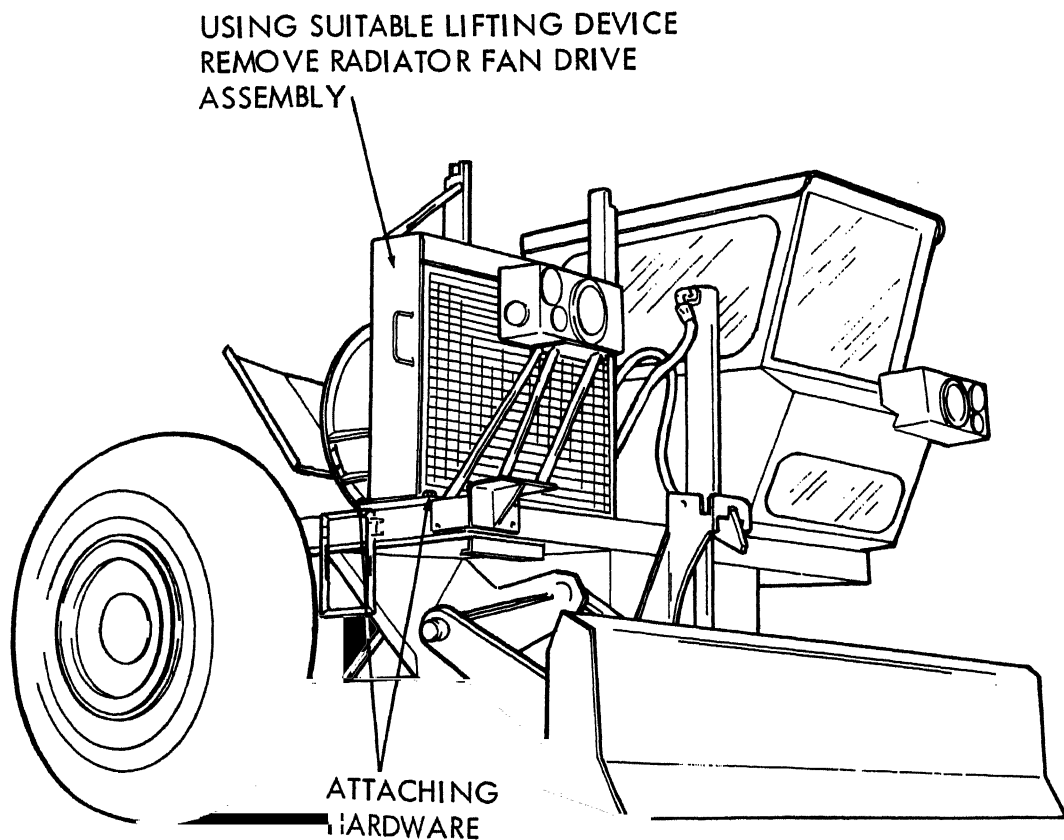
(1) Drain the cooling system. (TM 5-3810-295-12).

(2) Remove cover assembly and deck plates. (TM 5-3810-295-12).

(3) Disconnect radiator hoses (TM 5-3810-295-12).

(4) Refer to figure 13-13 and remove attaching hardware.

(5) With a suitable lifting device remove radiator and fan drive assembly.



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Figure 13-13. Carrier radiator, and fan drive assembly removal and installation.

b. Refer to figure 13-14 and disassemble the radiator assembly as follows:

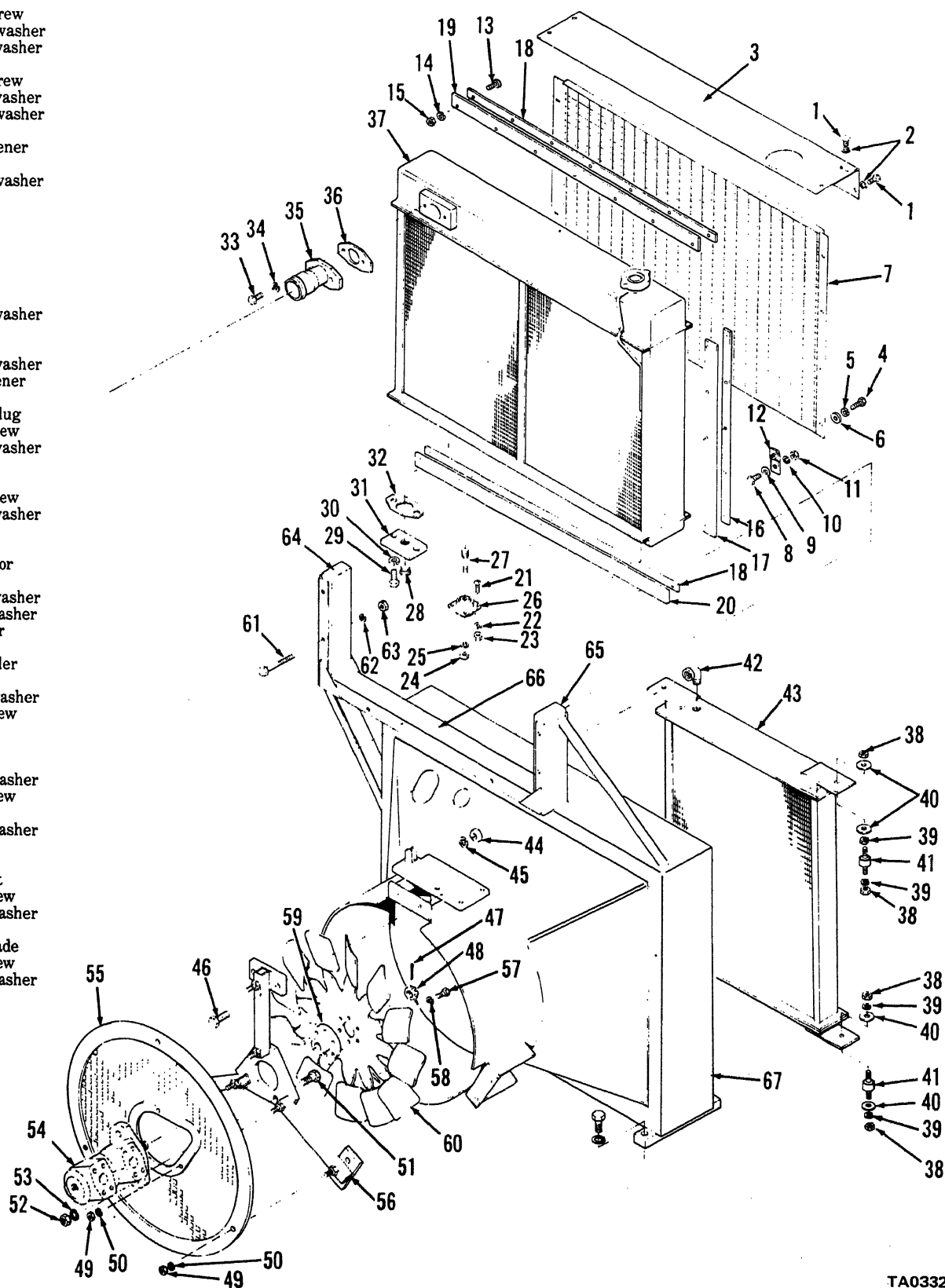
(1) Remove capscrews (1, fig. 13-14) and lock washers (2). Lift cover (3) from radiator assembly.

(2) Remove capscrews (4), lock washers (5) and flat washers (6). Carefully remove grille (7).

(3) Remove capscrews (8), flat washers (9), lock washers (10), and nuts (11). Remove vibration dampeners (12).

(4) Remove screws (13), lock washers (14) and nuts (15). From radiator (37) remove clamps (16) and (18) and seals (17), (19) and (20).

- 1 Capscrew
- 2 Lock washer
- 3 Cover
- 4 Capscrew
- 5 Lock washer
- 6 Flat washer
- 7 Grille
- 8 Capscrew
- 9 Flat washer
- 10 Lock washer
- 11 Nut
- 12 Dampener
- 13 Screw
- 14 Lock washer
- 15 Nut
- 16 Clamp
- 17 Seal
- 18 Clamp
- 19 Seal
- 20 Seal
- 21 Screw
- 22 Lock washer
- 23 Nut
- 24 Nut
- 25 Lock washer
- 26 Dampener
- 27 Stub
- 28 Pipe plug
- 29 Capscrew
- 30 Lock washer
- 31 Plate
- 32 Gasket
- 33 Capscrew
- 34 Lock washer
- 35 Flange
- 36 Gasket
- 37 Radiator
- 38 Nut
- 39 Lock washer
- 40 Flat washer
- 41 Isolator
- 42 Elbow
- 43 Oil cooler
- 44 Nut
- 45 Lock washer
- 46 Capscrew
- 47 Pin
- 48 Nut
- 49 Nut
- 50 Lock washer
- 51 Capscrew
- 52 Nut
- 53 Lock washer
- 54 Motor
- 55 Guard
- 56 Bracket
- 57 Capscrew
- 58 Lock washer
- 59 Hub
- 60 Fan blade
- 61 Capscrew
- 62 Lock washer
- 63 Nut
- 64 Block
- 65 Block
- 66 Block
- 67 Shroud



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Figure 13-14. Radiator assembly—exploded view.

(5) Remove screws (21), lock washers (22) and nuts (23). Remove nuts (24), lock washers (25) and dampeners (26). Remove stubs (27) from radiator (37).

(6) Remove pipe plug (28). Remove capscrews (29) and lock washers (30). Lift plate (31) and gasket (32) from radiator (37). Discard gasket.

(7) Remove capscrews (33) and lock washers (34). Remove flange (35) and gasket (36) from radiator (37). Discard gasket.

(8) Remove nuts (38), lock washers (39), flat washers (40), and isolators (41).

(9) Remove elbow (42) from oil cooler (43) and lift cooler (43) from shroud (67).

(10) Remove nuts (44), lock washers (45) and capscrews (46). Remove blade assembly from shroud (67).

(11) Remove cotter pin (47) and nut (48). Separate the blade assembly and guard assembly.

(12) Remove nuts (49), lock washers (50), capscrews (51), nuts (52), and lock washers (53).

(13) Separate hydraulic motor (54), guard (55) and bracket (56).

(14) Remove capscrews (57), and lock washers (58). Separate hub (59) and fan blade (60).

(15) Remove capscrews (61), lock washers (62) and nuts (63). Lift wood blocks (64), (65) and (66) from shroud (67).

13-37. Cleaning, Inspection and Repair

a. Remove sediment from core by pressure flushing and, if necessary, boil with cleaning solvent, Federal Specification P-D-680, or equivalent.

b. Inspect tanks for cracks, breaks or damaged seams. Repair or replace a defective tank.

c. Inspect for cracked or broken fins in the core. Repair damaged fins by soldering or replace defective core.

d. Inspect general condition of hardware and replace all gaskets and damaged hardware.

13-38. Reassembly and Installation

a. Refer to figure 13-14 and reassemble radiator and fan drive assembly as follows.

(1) Place wooden blocks (64), (65) and (66) in the radiator shroud (67). Install capscrews (61), lock washers (62) and nuts (63) and secure blocks.

(2) Assemble hub (59) to fan blade (60) with capscrews (57) and lock washers (58) and tighten securely.

(3) Assemble hydraulic motor (54) to bracket (56). Secure with capscrews (51), lock washers (53) and nuts (52).

(4) Assemble fan blade and hub assembly to motor shaft. Tighten nut (48) and install cotter pin (47).

(5) Assemble bracket (56) to shroud (67). Secure with cap screws (46), lock washers (45) and nuts (44).

(6) Assemble guard (55) to fan drive assembly. Secure with lock washers (50) and nuts (49).

(7) Assemble oil cooler (43) to shroud (67). Secure with isolators (41), flat washers (40), lock washers (39), and nuts (38).

(8) Install elbow (42) on oil cooler (43).

(9) Assemble flange (35) and new gasket (36) on radiator (37). Secure with lock washers (34) and screws (33).

(10) Assemble plate (31) and new gasket (32) on radiator (37). Secure with lock washers (30) and capscrews (29). Install pipe plug (28).

(11) Assemble stubs (27) to radiator (37) and install dampeners (26). Secure with lock washers (25) and nuts (24).

(12) Assemble clamps (16) and (18) and seals (17), (19) and (20). Secure with nuts (15), lock washers (14) and screws (13).

(13) Assemble radiator (37) to shroud (67). Clamp and seal assemblies must be properly positioned. Secure radiator with screws (21), lock washers (22) and nuts (23).

(14) Assemble dampeners (12) and secure with capscrews (8), flat washers (9), lock washers (10), and nuts (11).

(15) Assemble grille (7) to fan drive assembly secure with flat washers (6), lock washers (5) and capscrews (4).

(16) Assemble cover (3) to radiator assembly, secure with lock washers (2) and capscrews (1).

b. Refer to figure 13-13 and install radiator and fan drive assembly as described below.

(1) Using a suitable lifting device hoist fan drive assembly to carrier frame.

(2) Install attaching hardware as shown on figure 13-13.

(3) Connect radiator and hydraulic hoses (TM 5-3810-295-12).

(4) Install deck plates (TM 5-3810-295-12).

(5) Refill cooling system and check for leaks (TM 5-3810-295-12).

Section IX. REPAIR OF HYDRAULIC FAN DRIVE MOTOR

13-39. Description

The hydraulic fan drive motor is thermostatically controlled to drive the carrier engine fan. The engine fan supplies an air flow through the oil cooler and radiator to provide a means of cooling the carrier engine coolant

and oil.

13-40. Removal and Disassembly

a. Remove fan drive motor as described in paragraph 13-36b, sub paragraphs (10), (11), (12) and (13). Refer to fig. 13-14.

b. Refer to fig. 13-15 and disassemble fan drive motor as follows:

(1) Clamp the motor in a suitable vise with protective jaws, with cover up. Mark cover (2) and body (27) for proper relationship when reassembling.

(2) Remove bolts (1) and lift cover (2) off body (27).

(3) Remove the cartridge assembly from body (27).

Remove ring (3) and packing (4).

(4) Remove screws (5) and separate pressure plates (6) and (7). Remove bushing (8).

NOTE

When assembling or disassembling the cartridge components a suitable size standard piston ring compressor shall be used.

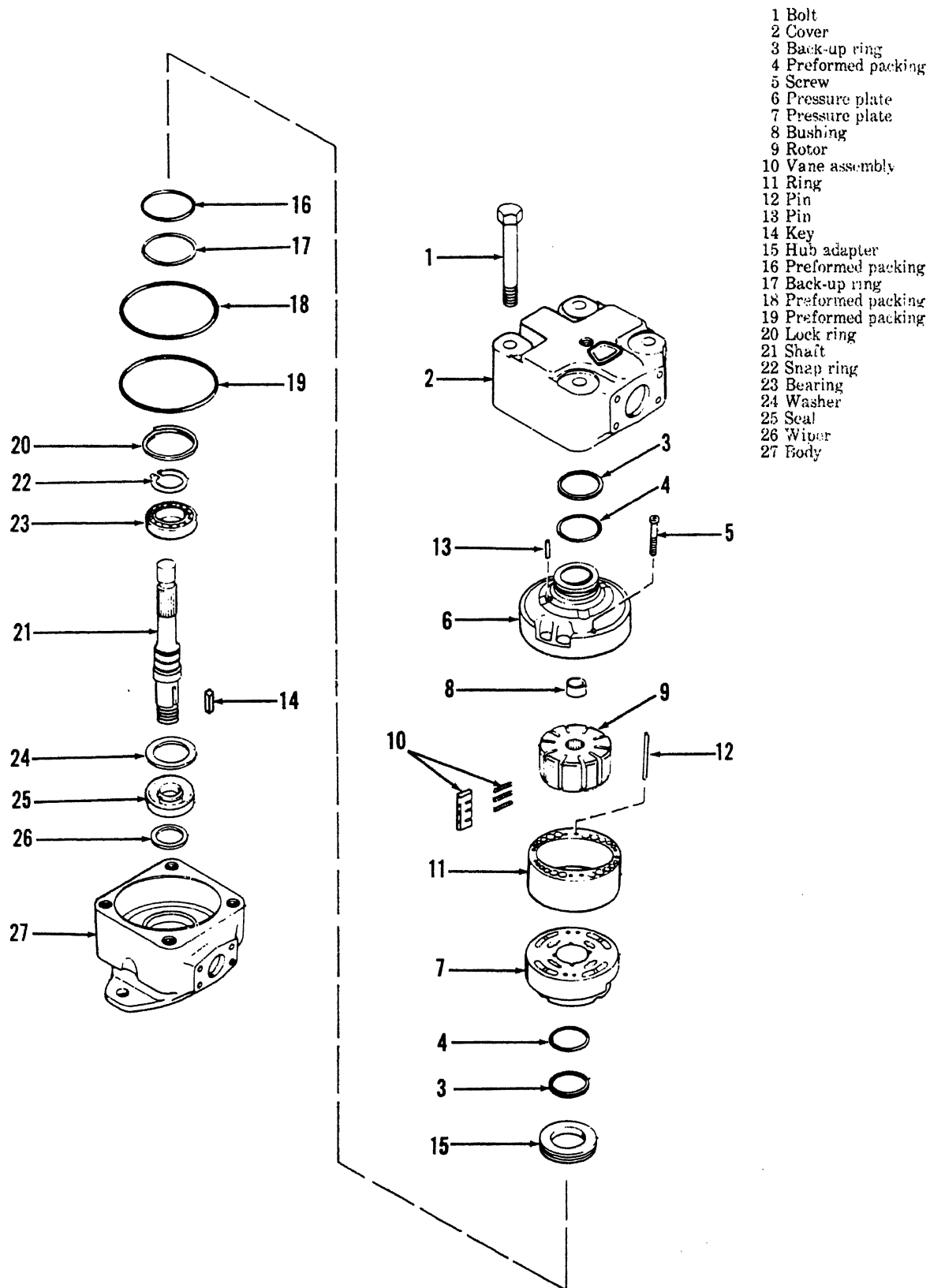
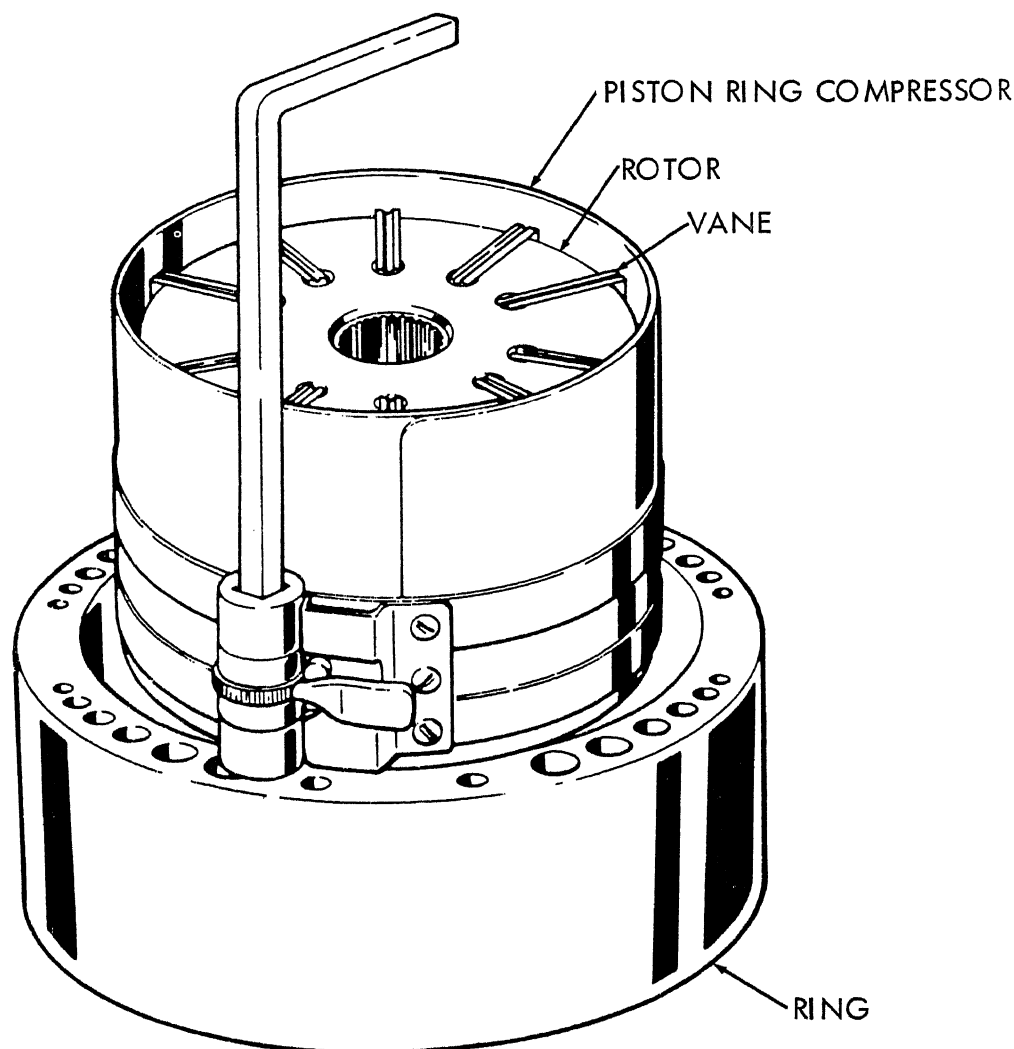


Figure 13-15. Fan drive hydraulic motor—exploded view.

TA033253

- (5) Carefully pull rotor (9) and vane assembly (10) half way out of ring (11) and install ring compressor (fig. 13-16).



TA033254

Figure 13-16. Rotor and vane assembly removal.

(6) Compress vanes (10, fig. 13-15) into rotor (9) and remove from ring (11). Remove ring compressor and remove vanes (10) from rotor (9).

(7) Remove pin (12) from ring (11) and pin (13) from plate (6).

(8) Remove shaft key (14). Carefully pull hub adapter (15) from body (27).

(9) Remove packing (16), ring (17) and packing (18) and (19).

(10) Remove lock ring (20) and with a soft headed hammer lightly tap shaft (21) from body (27).

(11) Remove snap ring (22) from shaft (21). Support the inner race of bearing (23) in an arbor press and

press shaft (21) off bearing.

(12) Remove washer (24), seal (25) and wiper (26) from body (27).

13-41. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent. Dry thoroughly with compressed air.

b. Discard shaft seal (25, fig. 13-15), wiper (26), all preformed packing, and back-up rings (17) and (3). Replace discarded parts with new when reassembling.

c. Check wearing surfaces of the cartridge pressure plates and ring for scoring and excessive wear. Remove

light score marks by lapping. Replace any heavily scored or badly worn parts.

d. Inspect vanes for burrs, wear and excessive play in the rotor slots. Using a medium india stone carefully dress down all burrs. Replace rotor if slots are worn. If vane tips are rounded, replace with a new vane and spring assembly.

e. Check bearing for wear, looseness, roughness and pitted or cracked races by rotating on the shaft while applying pressure. Replace bearing if defective.

f. Inspect seal and bushing mating surfaces on the shaft for scoring or wear. If mark cannot be removed by light polishing, replace shaft.

g. Check cover and body mating surfaced for burrs or foreign material. Mating surfaces must be clean and free of burrs before assembly.

13-42. Reassembly and Installation

a. Refer to figure 13-15 and reassemble motor as described.

(1) Install shaft wiper (26) in body (27). Grease shaft seal (25) and with spring facing out, press seal (25) into body (27). Place washer (24) against shaft seal.

(2) Press shaft (21) into bearing (23) while supporting inner race.

(3) Install snap ring (22) on shaft (21).

(4) With a soft headed hammer, lightly tap shaft (21) into body (27). Secure shaft with lock ring (20).

(5) With rotor (9) lying on a clean, flat, surface, slide the vanes and springs (10) into the rotor slots. Lift vanes slightly to insure springs are positioned in spring recesses of rotor.

(6) With a piston ring compressor of suitable size, compress vanes (10) in slots to clear the diameter of ring (11), (fig. 13-16).

CAUTION

Springs must remain seated in the spring recesses of the rotor as vanes are compressed.

(7) Position ring (11, fig. 13-15) on a flat surface and insert rotor and vane assembly one-quarter of the way into ring (11). Using a suitable size hardwood plug as a driver, release the ring compressor carefully

(vanes must not snap against the ring surface) and press the vanes and rotor flush with ring (11).

(8) Install pins (12) on pressure plate (7). Place the rotor, ring, and vane assembly over the pins on plate (7).

(9) Install pressure plate (6) against rotor (9) and ring (11). The porting in plate (6) will be 90° from plate (7).

(10) Carefully install screws (5) in the cartridge assembly. Tighten screws (5), the peripheral edges of ring (11) and plates (6) and (7) must remain flush.

NOTE

Tapping with a soft headed hammer may be required to maintain proper alignment of ring and plates.

(11) Install preformed packing (4) and back-up rings (3) on pressure plate hubs. Grease preformed packing.

NOTE

Preformed packing must be positioned in the concave side of the back-up ring.

(12) Install hub adapter (15) on pressure plate (7). Install preformed packing (16) and back-up ring (17) on adapter (15).

(13) Clamp body and shaft assembly in a vise with protective jaws.

(14) Install cartridge assembly on shaft (21), with hub adapter (15) toward body (27). Tap cartridge into position.

(15) Install preformed packing (19) into body (27).

(16) Install preformed packing (18) into cover (2). Install cover (2).

NOTE

Pin (13) must engage the pin hole in cover (2). To check engagement, turn the cover 30° in both directions. Cartridge must turn with cover.

(17) Install bolts (1) and tighten to 65—70 ft-lb (88—95 N · m) torque.

b. Refer to figure 13-14 and reinstall fan drive motor as described in paragraph 13-38a, subparagraphs (3), (4), (5) and (6).

Section X. REPAIR OF BATTERY BOX

13-43. Removal and Disassembly

a. Refer to TM 5-3810-295-12 and remove the battery box assembly.

b. Refer to figure 13-17 and disassemble battery box assembly as follows:

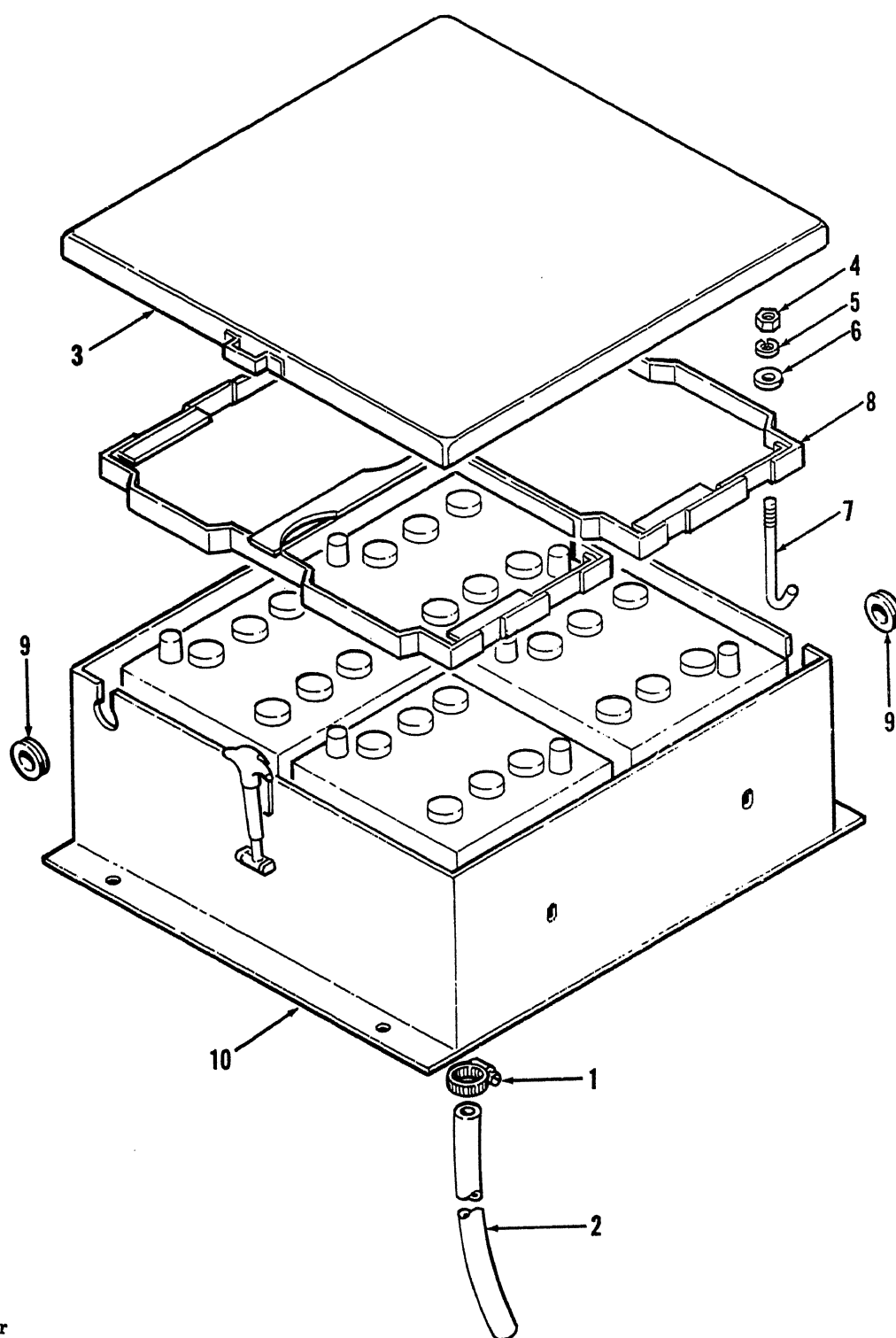
(1) Remove hose clamp (1) and pull drain hose (2) off the battery case (10).

(2) Unlatch and remove battery case cover (3).

(3) Remove nuts (4), lock washers (5), flat washers (6), and hook bolts (7).

(4) Remove battery retainers (8) from battery case (10).

(5) Remove grommets (9) from battery case (10).



- 1 Clamp
- 2 Hose
- 3 Cover
- 4 Nut
- 5 Lock washer
- 6 Flat washer
- 7 Hook bolt
- 8 Battery retainer
- 9 Grommet
- 10 Battery case

TA033255

Figure 13-17. Battery box—exploded view.

13-44. Cleaning, Inspection and Repair

- a. Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent.
- b. Inspect all parts for damage. Check all seams for cracks. Replace all defective parts.

13-45. Reassembly and Installation

- a. Refer to figure 13-17 and reassemble the battery box as follows:

- (1) Install grommets (9) in battery case (10).
- (2) Set retainers (8) in case (10) and install hook bolts (7). Secure with flat washers (6), lock washers (5) and nuts (4).
- (3) Place cover (3) on case (10) and latch in place.
- (4) Slide hose (2) on case (10) and secure with clamp (1).
- b. Refer to TM 5-3810-295-12 and install battery box assembly.

Section XI. REPAIR OF INSTRUMENT BOARD ASSEMBLY

13-46. Removal and Disassembly

- a. Refer to TM 5-3810-295-12 and figure 13-18 and remove the instrument board assembly from the carrier as follows:

- (1) Disconnect and tag all electrical leads to the instrument panel.
- (2) Remove screws (57, fig. 13-18), lock washers (58) and nuts (59).
- (3) Remove screws (60), lock washers (61) and nuts (62) and lift instrument board from carrier cab.
- b. Refer to figure 13-18 and disassemble the instrument board assembly.
- (1) Remove screws (1) and remove light switch (2) from instrument panel.
- (2) Remove nut (8), lock washer (7) and nut (6) and

remove starter switch cup and plunger assembly (5). Remove switch base (3) and gasket (4).

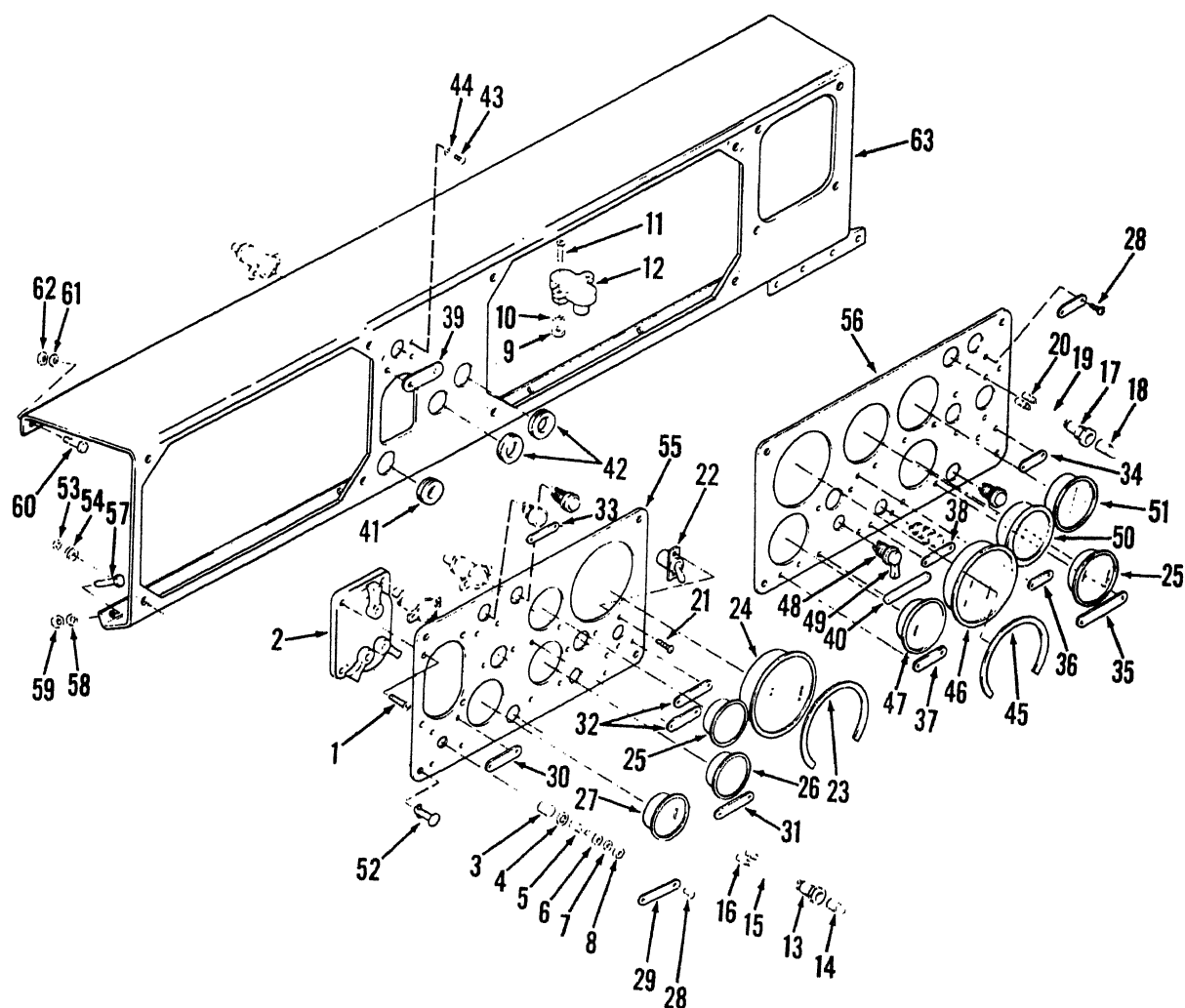
- (3) Remove nuts (9), lock washers (10) and screw (11). Remove circuit breaker (12) from instrument panel.

- (4) Remove light indicator socket (13), lamp (14) cable (15) and plug connectors (16).

- (5) Remove light indicator socket (17), lamp (18), cable (19) and plug connectors (20).

- (6) Remove screws (21) and pull toggle switch (22) from left panel (55).

- (7) If damaged, remove warning plate (23). Remove speedometer (24), pressure indicator (25), temperature indicator (26) and voltage indicator (27).



TA033256

- | | | | |
|----------------------------|--------------------------|-----------------------------|--------------------------|
| 1 Screw | 17 Socket w/lens | 33 Data plate (turn) | 49 Switch lever |
| 2 Light switch | 18 Lamp | 34 Data plate (outlet) | 50 Air gage |
| 3 Switch base | 19 Cable | 35 Data plate (converter) | 51 Temperature indicator |
| 4 Gasket | 20 Plug connector | 36 Data plate (air) | 52 Stud |
| 5 Cup and plunger assembly | 21 Screw | 37 Data plate (fuel) | 53 Retaining ring |
| 6 Nut | 22 Toggle switch | 38 Data plate (wiper) | 54 Rubber grommet |
| 7 Lock washer | 23 Warning plate | 39 Data plate (hi-beam) | 55 Left panel |
| 8 Nut | 24 Speedometer | 40 Data plate (main switch) | 56 Right panel |
| 9 Nut | 25 Pressure indicator | 41 Rubber grommet | 57 Screw |
| 10 Lock washer | 26 Temperature indicator | 42 Rubber grommet | 58 Lock washer |
| 11 Screw | 27 Voltage indicator | 43 Screw | 59 Nut |
| 12 Circuit breaker | 28 Drive screw | 44 Lock washer | 60 Screw |
| 13 Socket w/lens | 29 Data plate (starter) | 45 Warning plate | 61 Lock washer |
| 14 Lamp | 30 Data plate (lights) | 46 Tachometer | 62 Nut |
| 15 Cable | 31 Data plate (engine) | 47 Fuel indicator | 63 Instrument panel |
| 16 Plug connector | 32 Data plate (heater) | 48 Rotary switch | |

Figure 13-18. Instrument board assembly—exploded view.

(8) If necessary due to damage, remove drive screws (28) and data plates (29 thru 40).

(9) Remove rubber grommets (41 and 42). Remove screws (43) and lock washers (44).

(10) If damaged, remove warning plate (45) and

remove tachometer (46), fuel indicator (47), air gage (50), and temperature indicator (51).

(11) Remove rotary switch (48) and switch lever (49).

(12) Loosen stud (52) and remove retaining ring

(53) and rubber grommet (54). Remove left panel (55) and right panel (56) from instrument panel (63).

13-47. Cleaning, Inspection and Repair

a. Clean all parts using cleaning solvent (Federal Specification P-D-680, or equivalent) and dry thoroughly.

b. Inspect all parts for defects or damage. Check panel for cracks or breaks.

c. Repair or replace all defective parts. Replace all excessively damaged data plates.

d. Replace any cracked or dried rubber grommets.

e. Replace all inoperative indicators.

13-48. Reassembly and Installation

a. Refer to figure 13-18 and reassemble the instrument board assembly as follows:

(1) Position left panel (55) and right panel (56) to instrument panel (63) and install studs (52), rubber grommets (54) and retaining clips (53).

(2) Install rotary switch lever (49) and rotary switch (48) to the instrument panel.

(3) Install warning plate (45), tachometer (46), fuel indicator (47), air gage (50), and temperature indicator (51) if removed during disassembly.

(4) Install rubber grommets (41 and 42) and mountings screws (43) and lock washers (44).

(5) Install new data plates (29-40) that were

removed in disassembly.

(6) Install new warning plate (23) if necessary. Install speedometer (24), pressure indicator (25), temperature indicator (26) and voltage regulator (27).

(7) Install toggle switch (22) into panel (55) and secure with screws (21).

(8) Install light indicator socket (17), lamp (18), cable (19) and plugs (20).

(9) Install light indicator socket (13) lamp (14) cable (15) and plugs (16).

(10) Install circuit breaker (12) to control panel and secure with screws (11), lock washers (10) and nuts (9).

(11) Assemble switch base (3) and gasket (4) to starter switch (5). Secure starter switch cup and plunger assembly (5) to control panel with nut (6), lock washer (7) and nut (8).

(12) Install light switch (2) to control panel and secure with screws (1).

b. Refer to TM 5-3810-295-12 and figure 13-18 and install the control panel assembly in the carrier cab.

(1) Place instrument board in carrier cab and secure with screws (57), lockwashers (58), nuts (59), screws (60), lock washers (61) and nuts (62).

(2) Connect all electrical leads as tagged in the removal procedure.

CHAPTER 14

REPAIR OF CARRIER ENGINE

Section I. GENERAL

14-1. General

The carrier engine is a four-cycle, V-8, Cummins Diesel V-903 engine.

14-2. Removal

Refer to chapter 12 and remove the carrier engine.

14-3. Removal of Engine Accessories

a. Refer to TM 5-3810-295-12 and chapter 13 and remove the following engine accessories:

- (1) Oil lines and filters
- (2) Oil cooler

- (3) Alternator
- (4) Starting motor
- (5) Water pump
- (6) Fuel pump and lines
- (7) Air compressor
- (8) Fan, fan hub, belts and accessories

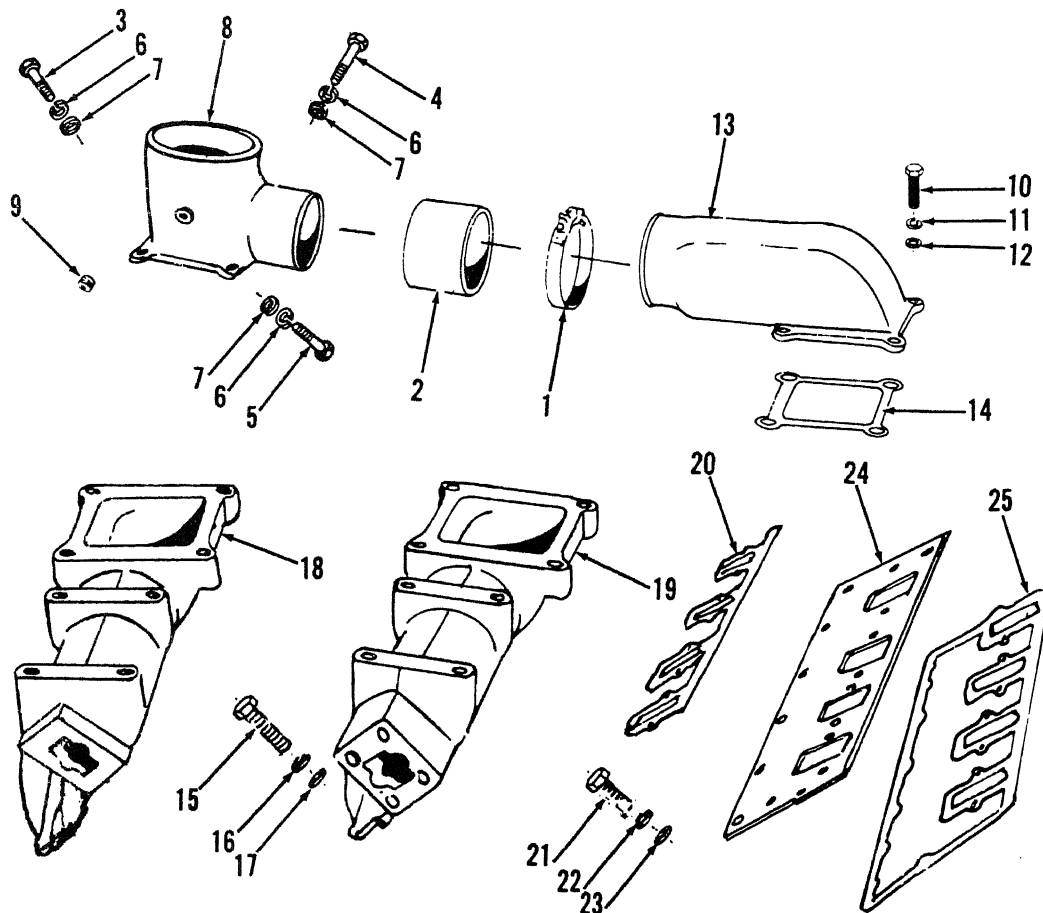
b. Parts removed from the engine should be stored together so they will be available for reassembly. Items that have machined faces, which could be damaged, should be stored on wooden blocks, racks, or parts dolly.

Section II. AIR INTAKE AND EXHAUST MANIFOLDS

14-4. Removal and Disassembly

- a. Refer to figure 14-1. Remove hose clamp (1) and
- (2). Remove screws (3), (4) and (5), lock washers

(6) and flat washers (7). Lift connection elbow (8) from the manifold. Remove pipe plug (9).



TA033257

- 1 Hose clamp
- 2 Air hose
- 3 Screw
- 4 Screw
- 5 Screw
- 6 Lock washer
- 7 Washer
- 8 Connection
- 9 Pipe plug

- 10 Screw
- 11 Lock washer
- 12 Washer
- 13 Crossover
- 14 Gasket
- 15 Screw
- 16 Lock washer
- 17 Washer

- 18 Intake manifold (right)
- 19 Intake manifold (left)
- 20 Gasket
- 21 Screw
- 22 Lock washer
- 23 Washer
- 24 Plate
- 25 Gasket

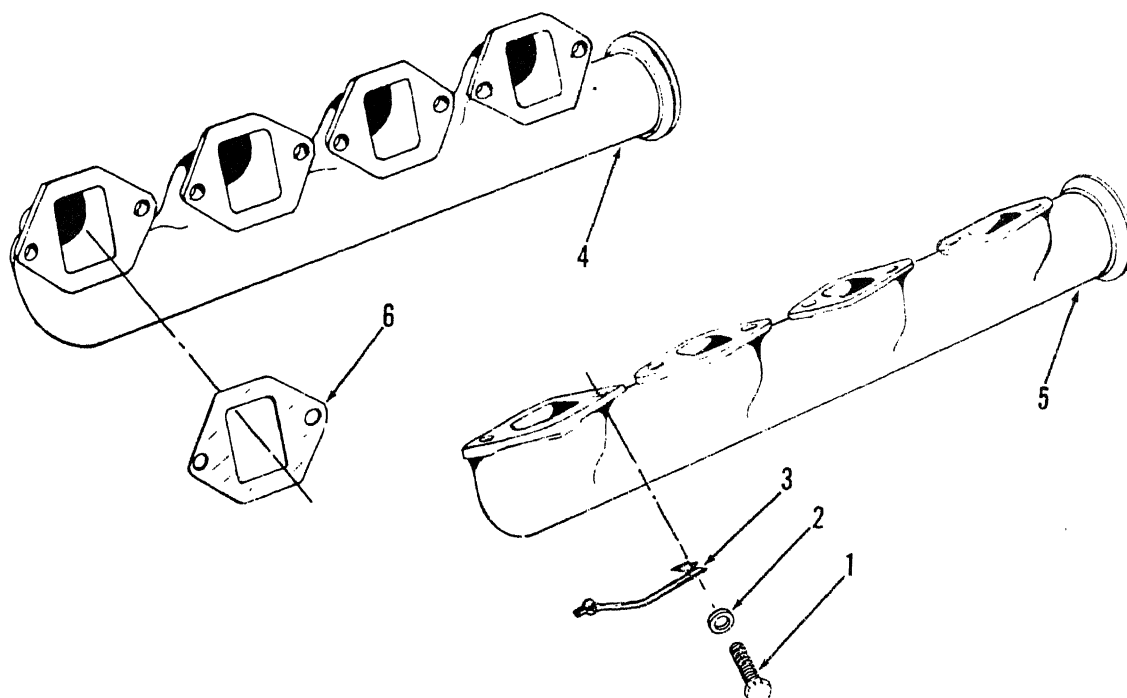
Figure 14-1. Intake manifold assembly—exploded view.

b. Remove screws (10), lock washers (11), and flat washers (12). Lift crossover (13) from the manifold. Remove gasket (14).

c. Remove screws (15), lock washers (16) and flat washers (17) from the right and left side manifolds (18) and (19). Remove gasket (20), screws (21),

lock washers (22) and flat washers (23) from the engine. Remove plate (24) and gasket (25).

d. Refer to figure 14-2 for removal procedures for the exhaust manifolds. Remove screws (1), washers (2) and lock plates (3). Lift manifolds (4) and (5) from the engine. Remove gaskets (6).



TA033258

- 1 Screw
- 2 Washer
- 3 Lock plate
- 4 Manifold (right)
- 5 Manifold (left)
- 6 Gasket

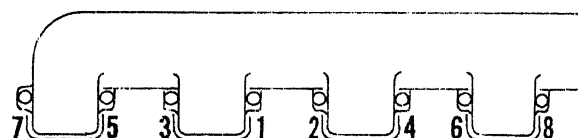
Figure 14-2. Exhaust manifold assembly—exploded view.

14-5. Cleaning, Inspection and Repair

- a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent before inspection.
- b. Replace all gaskets.
- c. Inspect manifolds for indications of cracks or other damage. Check air hose for signs of wear, abrasion, or cuts. Replace all defective parts.

to 30—32 ft-lb (41—43 N · m) in 10 ft-lb (14 N · m) increments in the sequence shown in figure 14-3.

14-6. Reassembly and Installation



TA033259

Figure 14-3. Intake manifold tightening sequence.

- a. Refer to figure 14-2. Install gaskets (6) and assemble exhaust manifold (5) to engine. Lubricate screws (1) with high temperature lubricant and secure exhaust manifolds with screws (1), washers (2) and lock plates (3). Tighten screws to 45—50 ft-lb (61—68 N · m) in 15 ft-lb (20 N · m) increments. Install right side manifold in the same manner.

- d. Install left side intake manifold (19) in the same manner as above.

- b. Refer to figure 14-1. Position gasket (25), plate (24) and gasket (20). Secure with screws (21), lock washers (22) and flat washers (23).

- e. Install gasket (14) and crossover connection (13) and secure with screws (10), lock washers (11) and flat washers (12). Install hose (2) and clamp (1) to the crossover connection. Install connection (8) and secure with screws (3), (4) and (5), lock washers (6) and flat washers (7). Install pipe plug (9). Install other end of hose (2) and secure with clamp (1).

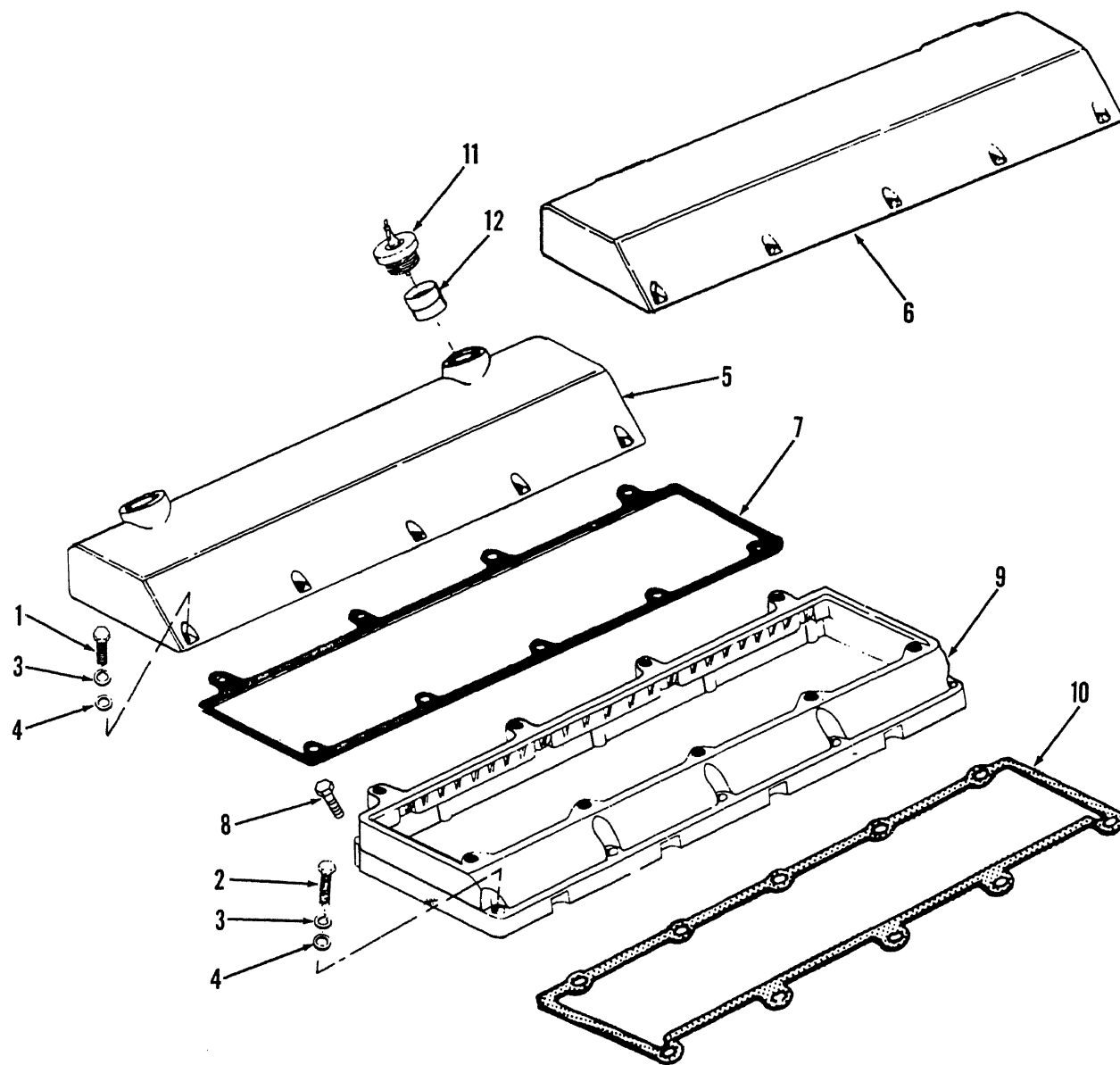
- c. Position right side manifold (18) on push rod cavity cover on the cylinder head. Install screws (15), lock washers (16) and flat washers (17). Tighten screws

Section III. ROCKER COVERS AND LEVERS

14-7. Removal

Refer to figure 14-4.

a. Remove rocker covers by removing screws (1) and (2), lock washers (3), and washers (4).



TA033260

- 1 Screw
- 2 Screw
- 3 Lock washer
- 4 Washer
- 5 Cover
- 6 Cover

- 7 Gasket
- 8 Screw
- 9 Housing
- 10 Gasket
- 11 Filler cap
- 12 Filler tube

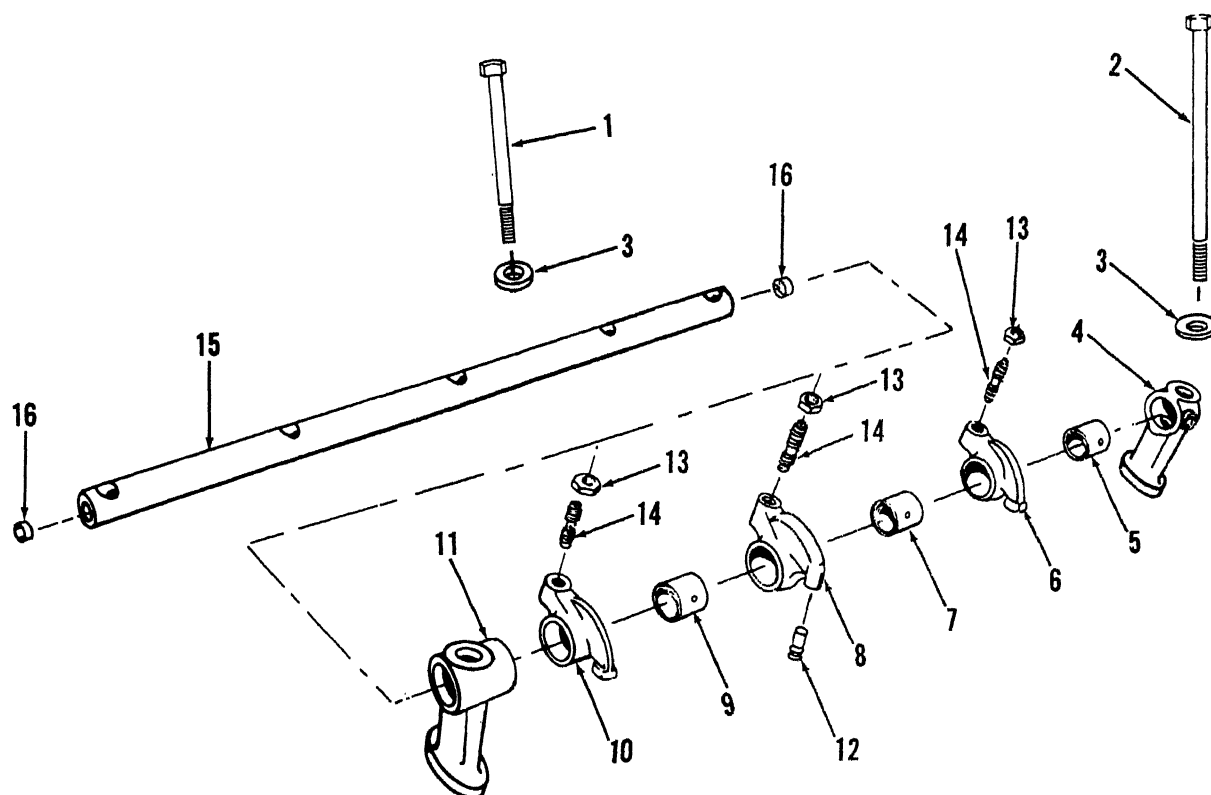
Figure 14-4. Rockers levers cover—exploded view.

b. Lift covers (5) and (6) from housings (9) and remove gaskets (7).

c. Remove screws (8) and lift housings (9) from the cylinder heads. Remove gaskets (10).

d. Remove filler cap (11) and filler tube (12).

e. Refer to figure 14-5. Remove screws (1) and (2), and washers (3). Lift rocker lever assembly from the cylinder head.



TA033261

1 Screw
2 Screw
3 Washer
4 Bracket
5 Bushing
6 Exhaust lever
7 Bushing
8 Injector lever

9 Bushing
10 Intake lever
11 Bracket
12 Socket
13 Nut
14 Adjusting screw
15 Rocker shaft
16 Plug

Figure 14-5. Rocker levers—exploded view.

14-8. Disassembly

Refer to figure 14-5.

NOTE

Tag rocker levers for correct position as removed.

a. Remove brackets (4), bushings (5), exhaust levers (6), bushings (7), injection levers (8), bushings (9), intake levers (10), and brackets (11) from rocker shafts (15).

b. Remove adjusting screw locknuts (13) and adjusting screws (14) from rocker levers.

c. Remove cup plugs (16) from rocker shaft (15).

14-9. Cleaning, Inspection, Repair

a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent before inspecting.

b. Check rocker lever for surface cracks or other damage. Replace all defective parts.

c. Check rocker lever bushings for wear. Bushings worn beyond 1.1915 inches shall be replaced.

d. Inspect intake and exhaust rocker lever crosshead contact surface. Replace lever if a wedge shaped pattern is evident.

e. Check to assure the ball end of rocker lever adjusting screws are true spheres. If worn flat on bottom,

replace.

f. Injector rocker lever sockets must be replaced, if any indication of wear is detected.

g. Check to see that all lubricating passages are open and unobstructed.

h. Remove socket if broken or worn. Press out by drilling a small hole above socket. After socket is removed, spot weld hole closed, install and stake new socket in hole.

i. Blow out oil passages with compressed air.

j. Install new steel bushings, press flush with surface.

14-10. Reassembly

Refer to figure 14-5.

a. Dip rocker lever shaft cup plugs (16) in lubricating oil to prevent galling. Drive plugs (16) in shaft (15).

b. Assemble rocker lever adjusting screws (14) and nuts (13) in rocker levers.

c. Coat rocker lever shaft with clean lubricating oil and position rocker lever bracket (11) on shaft. One end

of shaft (15) has stamped arrowhead, which must line with arrowhead on bracket (11) during assembly.

CAUTION

Levers can easily be installed in the wrong position; care must be taken to install in correct position.

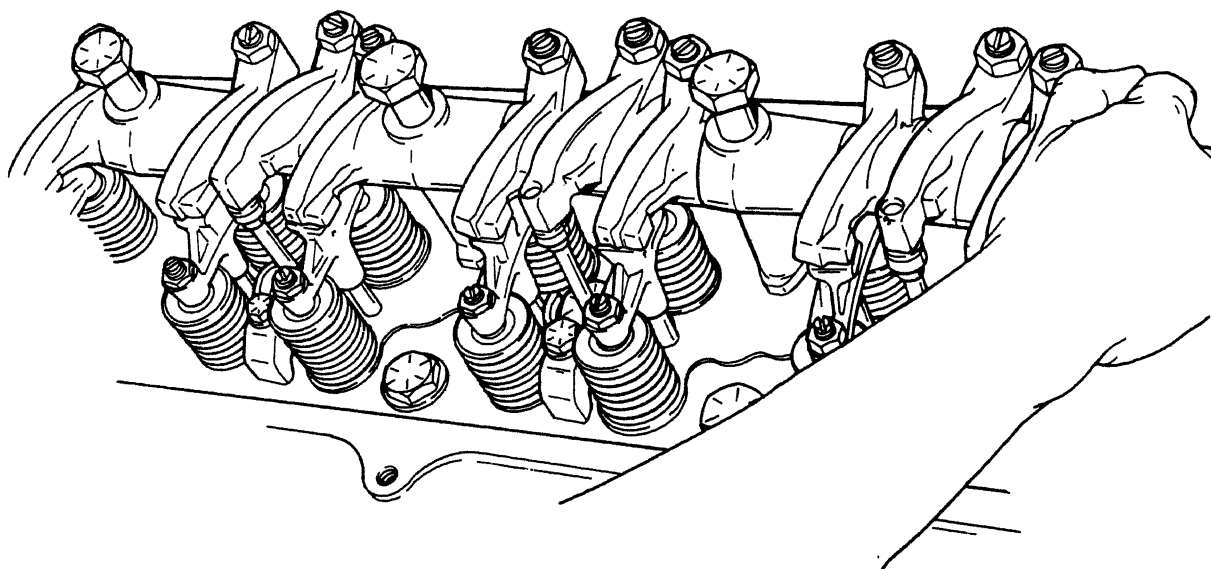
d. Slide exhaust rocker lever (10), bushing (9), injector lever (8), bushing (7), intake lever (6), and bushing (5) onto rocker lever shaft. Slide bracket (4) onto shaft, and repeat until all levers are in place.

NOTE

To aid in handling, insert long cylinder head capscrew with washer through bracket and shaft at each end of shaft.

14-11. Installation

a. Refer to figure 14-6. Position rocker lever assembly to cylinder head. Lubricate screws and washers with clean lubricating oil. Place washers (3, fig. 14-5) on screws (1) and (2) and install in head; snug tighten.



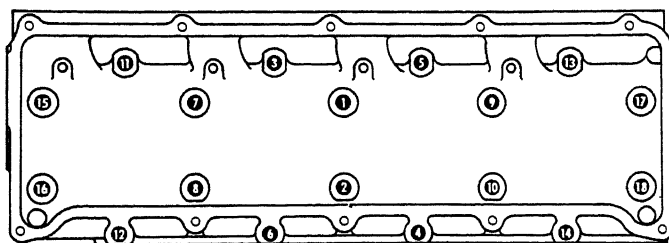
TA033262

Figure 14-6. Installing rocker lever assembly.

NOTE

Screws securing the rocker assembly are part of cylinder head screws.

b. Torque all cylinder head screws to 280—300 ft-lb (380—407 N · m), 50 ft-lb (68 N · m) increments. See figure 14-7 for torquing sequence.



TA033263

Figure 14-7. Cylinder head torquing sequence.

Section IV. INJECTORS, PUSH RODS AND TAPPETS

14-12. Removal and Disassembly

Refer to figure 14-8.

NOTE

Mark push rods for installation in identical position during reassembly.

- a. Remove push rods (1) and (2) from cylinder head.
- b. Remove screws (3), lock washers (4), and tappet guides (5).
- c. Pull tappet assemblies (8) and (13) from block with a wire hook or small slide hammer.
- d. Remove springs (6) and (7) from each tappet assembly and discard.

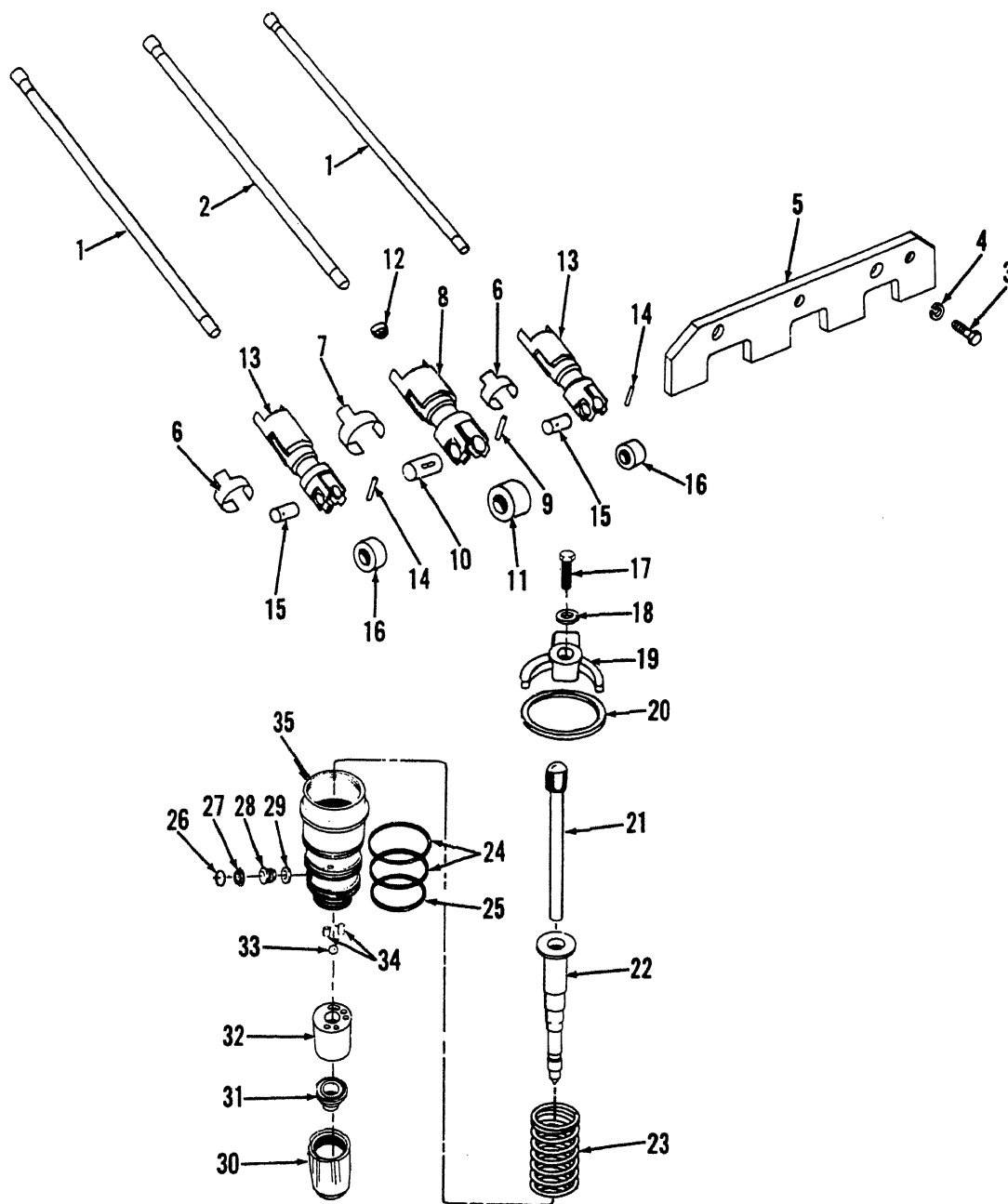
- e. Place injector tappets (8) in a suitable holding fixture and remove lock wire (9).

- f. Press roller pin (10) from body. Discard lock wire (9) and pin (10).

NOTE

If push rods and tappets are to be reused, best results will be attained when the push rods are kept with their mating tappet.

- g. Remove injector roller (11).
- h. Press or knock out cam follow socket (12) with a small round punch.



TA033264

- | | | |
|----------------------|----------------------|----------------------|
| 1 Valve push rod | 13 Valve tappet | 25 Preformed packing |
| 2 Injector push rod | 14 Lock wire | 26 Clip |
| 3 Screw | 15 Roller pin | 27 Screen |
| 4 Lock washer | 16 Valve roller | 28 Plug |
| 5 Tappet guide plate | 17 Screw | 29 Gasket |
| 6 Tappet spring | 18 Washer | 30 Retainer |
| 7 Tappet spring | 19 Clamp | 31 Cup |
| 8 Injector tappet | 20 Spacer | 32 Barrel |
| 9 Lock wire | 21 Link | 33 Check ball |
| 10 Roller pin | 22 Plunger | 34 Spiral pin |
| 11 Injector roller | 23 Spring | 35 Adapter |
| 12 Cam follow socket | 24 Preformed packing | |

Figure 14-8. Injectors, push rods and tappets—exploded view.

i. From valve tappets (13) remove lock wire (14), roller pins (15), and valve rollers (16) using the same procedures outlined for injector tappets.

j. Remove injectors by removing screws (17), washers (18), clamps (19) and spacers (20).

CAUTION

Do not use screwdriver or other hard objects in adapter locating holes during injector removal.

k. Using a suitable injector removing tool, lift injector assembly from the cylinder head.

l. Remove injector link (21) from injector assembly.

NOTE

Injector barrels and plungers are class fit; do not interchange.

m. Remove injector plunger (22) and spring (23). Store plunger by standing on coupling end.

n. Remove and discard preformed packing (24) and (25).

o. Remove screen clip (26) and filter screen (27). Discard screen if damaged. Do not remove adjustable orifice plug (28) and gasket (29) from inlet groove.

p. Screw off cup retainer (30) and remove cup (31), barrel (32) and check ball (33).

q. Remove spiral pins (34) from adapter (35).

14-13. Cleaning, Inspection

a. Clean all parts in cleaning solvent, Federal Specification P-D-680, or equivalent before inspecting.

b. All carbon varnish must be removed from injector parts. Injector barrel, plunger, and cup should be cleaned in an ultra-sonic bath.

c. Using a small wire, clean the injector cup spray holes. Care must be taken not to alter the size of the spray holes.

d. Dry all parts with clean compressed air.

e. Inspect tappet assembly components as follows:

(1) Tappet sockets shall be checked by "bluing" the ball end of the corresponding push rod and rotating in tappet; a full seat should be indicated. Replace tappet socket if worn excessively.

(2) Check for scored, flaked or chipped rollers, discard damaged parts.

(3) Using an accurate micrometer, measure the tappet body outside diameter for wear. Replace body if measurement is less than 1.3965 inches.

(4) Measure rollers outside and inside diameters. The outside diameter shall be greater than 1.1670 inches. The inside diameter shall be less than 0.6300 inch. Roller must be replaced if these requirements are not met.

f. Check push rods as described in the following steps.

(1) Check injector and valve ball end with a radius gauge. Ball end radius shall measure 0.3110—0.3125 inch. Socket end radius shall be 0.250—0.252 inch. If these readings are not met, replace push rod.

(2) Check sockets of push rods with a one-half inch "bleed" check ball, which should "blue" 80% of the seat area. Extreme wear on either end of push rods will result in loss of lubricating oil pressure and may not permit proper injector and valve adjustment. Replace push rods that indicate extreme wear.

(3) With push rods supported at ends by pivot points having a common axis, and with a dial indicator placed midway between ends, check run-out. Run-out must not exceed 0.025 inch total indicator reading when rod is rotated 360°. If this cannot be met, rod is bent and must be replaced.

g. Check injector components as outlined.

(1) Check injector link for wear. Replace if wear appears excessive.

CAUTION

Injector plunger must be handled with care to prevent damage which could render it useless.

(2) Check injector plunger coupling closely for metal seizure. This will indicate any scuffing and scoring.

(3) Check for metal displacement or measurable wear at top of machined area of plunger, on opposite side at bottom of plunger or at mid-point. If worn excessively, replace and return for fitting of a new plunger.

(4) Replace if a noticeable surface disruption is evident along the plunger length.

(5) Check area where plunger is swaged to coupler for cracks and looseness, by attempting to rotate by hand.

(6) Check spring for excessive wear or mutilation.

(7) Check injector springs on an accurate spring tester. Replace any spring that compresses to 1.663 inches under a load of less than 138 pounds.

(8) Inspect injector cup spray holes and tip with a magnifying glass. Discard cup if there are indications of abrasive wear, corrosion damage, excessive heat, or distorted spray holes.

(9) Inspect cup for plunger seat pattern. If plunger seat covers less than 40 percent continuous area around cup, cup cone, or plunger bore, it must be replaced (fig. 14-9).

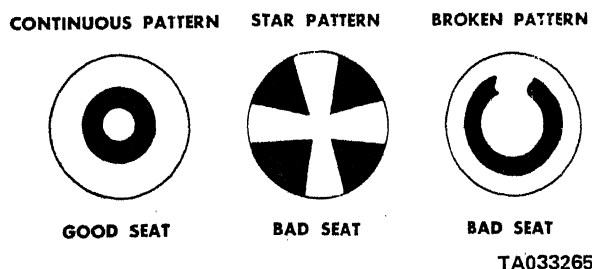


Figure 14-9. Seat pattern of plunger in cup.

(10) Check injector cup barrel surface for mutilation and flatness. If mutilation or unevenness are found, lap for repair.

(11) Inspect cup retainer for damaged threads. Check for nicks and burrs outside and inside of cone area.

(12) Inspect injector barrel plunger bore for scoring. If bore is scored excessively, barrel and plunger must be replaced.

(13) Using a strong magnifying glass, check for burrs, carbon, and distorted radii in orifice. If metering orifice is damaged, replace.

(14) Check fuel passage plugs for looseness and barrel for cracks.

(15) Check injector barrel surfaces for mutilation and flatness. If unevenness or damage is found, lap to repair.

(16) Check injector ball seat for nicks or burrs. If the seat is marred, lap the barrel and replace the check ball.

(17) Check adapter balance orifice for burrs or other obstructions. Check that both fuel passages are open. Check preformed packing grooves for nicks or burrs.

(18) Inspect barrel mating surface on adapter for nicks or burrs. If any damage is found, lap to repair.

14-14. Reassembly

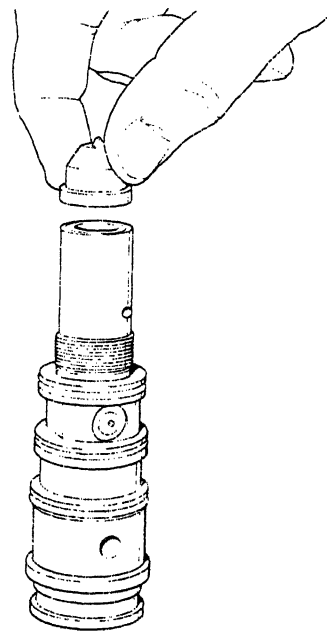
Refer to figure 14-8.

a. Reassemble the injector assembly as follows:

(1) Place check ball (33) into top of barrel (32).

(2) Holding barrel with check ball up, place new adapter spiral pins (34) into barrel. Couple adapter (35) and barrel (32) together with the spiral pins.

(3) With adapter and barrel placed with barrel up, place cup (31) on barrel (fig. 14-10).



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Figure 14-10. Installing cup on barrel.

(4) Coat cup retainer threads and cup flange area, with 20- or 30-wt. lubricating oil and assemble retainer (30, fig. 14-8) to adapter (35). Screw retainer down finger tight and loosen one-quarter turn.

(5) Immerse injector plunger (22) in clean injector test oil and install in adapter without spring.

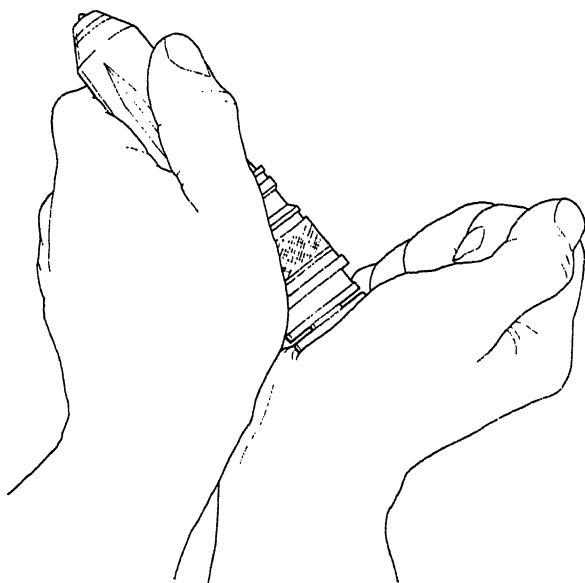
(6) Using a suitable fixture align cup (31) and plunger (22). Torque retainer to 50 ft-lb (68 N • m).

(7) Check cup to plunger alignment. If alignment

is improper, loosen retainer and rotate cup one-quarter turn and retorque retainer to 50 ft-lb (68 N · m). Repeat as necessary.

(8) Remove plunger and lubricate with test oil. Install spring (23) on plunger and insert into adapter.

(9) Check cup spray pattern by removing plunger and spring and fill barrel and cup full of fuel oil. Insert plunger, less spring, into injector forcing fuel out spray holes (fig. 14-11).



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Figure 14-11. Checking open cup spray holes.

WARNING

Any time fuel is forced from cup spray holes be sure to keep hands or body out of spray stream to prevent injury.

(10) Remove plunger and reinstall spring.

(11) Lubricate and install new preformed packing (24, fig. 14-8) and (25) into proper grooves in adapter.

(12) Install new fuel screen (27) and retainer (26).

(13) Place injector assembly in a clean area until ready to leak test and use.

b. Reassemble tappet assembly in the following method. (See fig. 14-8.)

(1) Press new insert (12) in tappet body (8), being sure insert is securely seated. Tappet body must be supported in a manner not to spring the tappet forks.

(2) Place tappet body in a V-block with the lockwire side up.

(3) Place new roller (11) in tappet body. Install lockwire (9) in roller pin (10). With a 0.006-inch shim or feeler gauge between side of roller and tappet fork, press pin (10) in tappet body through roller (11).

(4) Remove shim and check that roller rotates

freely. If any restriction is felt, pin should be removed and a new pin installed.

(5) Repeat paragraphs (2), (3), and (4) above to assemble roller (16), pin (15), and lockwire (14) to valve tappet body (13).

14-15. Installation

a. Refer to figure 14-8. Install spring clips (6) and (7) on all tappets except injector tappets used at No. 2 and No. 6 cylinders.

CAUTION

Spring clip must not be on tappets No. 2 and No. 6 when checking injection timing.

b. Dip tappet rollers (11) and (16) in clean engine oil and install valve and injector tappets in tappet bores of block.

c. Hold tappet plate (5) across tappet and tap lightly with a soft headed hammer to align tappets.

d. Place feeler gauge on shim between tappet plate on both sides of injector tappet to maintain a 0.010 inch (minimum) clearance, tighten capscrews to 18 to 22 ft-lb (24—30 N · m) torque.

NOTE

Valve tappets may have 0.010- to 0.030-inch clearance between plate and tappet, if required, to maintain the 0.010-inch minimum clearance between injector tappets and plate.

e. Install cylinder head per paragraph 14-21 if removed.

f. Install injector push rod (2) in No. 2 cylinder on right bank and No. 6 on left bank.

g. Using an approved timing fixture check injection timing. Timing may be advanced or retarded by changing camshaft key. If timing check shows a timing change is desirable, select next advance or retard key from listing in table 14-1.

Table 14-1 Camshaft Key Data

Key part No.	Amount of offset (inch)	Degrees changed
S-302	0.000	0°
200711	0.007	0.5° Advance
200709	0.015	1.0° Advance
200708	0.023	1.5° Advance
20079	0.015	1.0° Retard
200708	0.023	1.5° Retard
200714	0.039	2.5° Retard
216294	0.0035	0.18°
216782	0.011	0.75°

h. Remove injector tappets used to check injection timing and install new spring clip (7).

i. Lubricate preformed packing with clean oil. Lower injector assembly into head. Align injector so screen is toward center vee.

j. With a clean blunt object on injector body, "seat" injectors by giving a quick hard push. A "snap" should be heard and felt as cup seats in head.

k. Install links (21), spacers (20), clamp (19), washers (18) and screws (17).

CAUTION

When installing clamps, make sure the hold down yokes do not contact crosshead stems.

l. Torque screws (17) to 30 to 35 ft-lb (41–47 N • m). Check injector plunger for freedom of up and

down movement.

m. Coat ball end of push rods with clean engine oil. Install push rods (1) and (2). Engage push rods adjusting screws in push rod sockets.

Section V. CYLINDER HEAD**14-16. Removal and Disassembly**

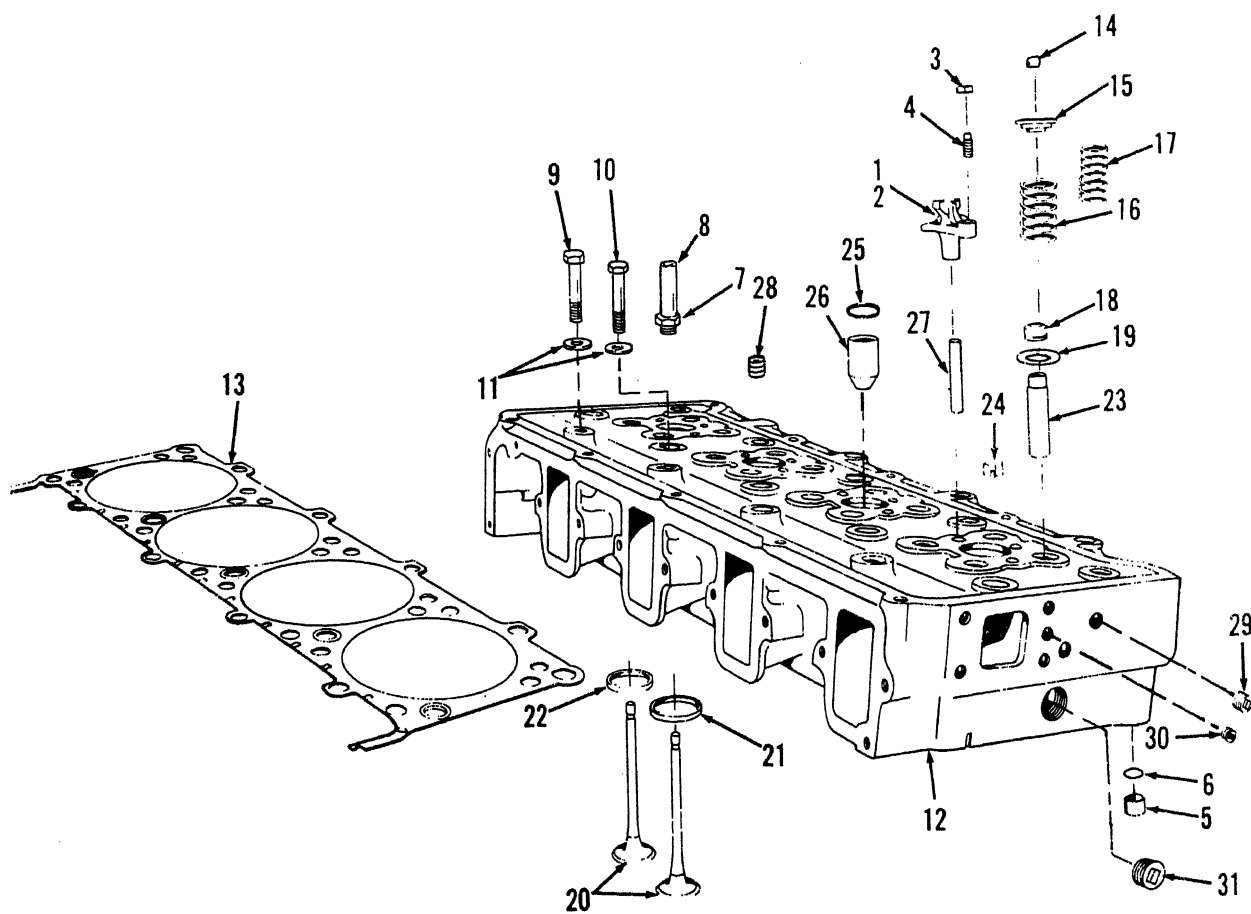
a. Refer to figure 14-12. Remove cylinder head as follows:

- (1) Remove intake and exhaust crossheads (1) and (2).
- (2) Remove crosshead nuts (3) and adjusting screws (4).
- (2) Remove dowels (5) packing (6), tube nuts (7),

and tube connector (8) from the cylinder head. Discard packing.

(3) Remove headbolts (9) and (10) and washers (11).

(4) Lift cylinder heads (12) from engine block. Remove gaskets (13).



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- 1 Intake crosshead
- 2 Exhaust crosshead
- 3 Crosshead nut
- 4 Adjusting screw
- 5 Dowel
- 6 Preformed packing
- 7 Nut
- 8 Tube connector
- 9 Headbolt
- 10 Headbolt
- 11 Washer

- 12 Cylinder head
- 13 Gasket
- 14 Lock
- 15 Guide
- 16 Outer spring
- 17 Inner spring
- 18 Seal
- 19 Wear plate
- 20 Valves
- 21 Insert

- 22 Insert
- 23 Guide
- 24 Ring
- 25 Preformed packing
- 26 Sleeve
- 27 Guide
- 28 Plug
- 29 Plug
- 30 Plug
- 31 Plug

Figure 14-12. Cylinder head—exploded view.

b. Disassemble cylinder head as described below.

(1) With a suitable valve spring compressor, figure 14-13, compress valve springs and remove locks (14, fig. 14-12).

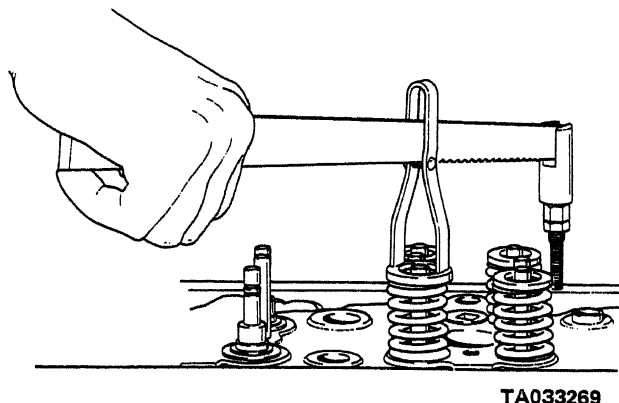


Figure 14-13. Valve spring compressor, typical.

(2) Release valve springs and remove guides (15), outer springs (16), inner springs (17), valve seals (18), and wear plates (19).

CAUTION

When valve springs are removed on an assembled engine, piston must be up to support valves in cylinder. Springs must be replaced before barring the engine or valve will drop into cylinder necessitating cylinder head removal.

(3) Remove valves (20). If necessary per paragraph 14-18 remove intake inserts (21), exhaust inserts (22), and valve guides (23). Identify valves as to location.

(4) Remove rings (24), preformed packing (25), guides (27), plug (28), plug (29), plug (30), and plug (31).

14-17. Cleaning

a. Clean all parts with cleaning solvent, Federal Specification P-D-680, or equivalent before inspecting. Replace all seals and gaskets.

b. Clean cylinder head thoroughly with steam and clean all ports and openings with a soft bristle brush.

All carbon must be removed from the intake manifold section, bottom face of the head, and from the valve ports and guide bores.

c. Flush out water passages to remove any accumulation of salt, slime, or sludge.

d. Clean fuel passages with a long handled brush. Flush passages with cleaning solvent to remove deposits.

14-18. Inspection and Repair

a. Inspect heads for water leaks or cracks in the combustion chamber, exhaust ports, or around the valve seats. Check the cylinder head for leaks as follows:

(1) Install an injector sleeve holding tool or a scrap injector assembly in each injector sleeve. Tighten hold-down screws to 10—12 ft-lb (14—16 N • m) torque to seal lower end of injector sleeve.

(2) Seal off the water holes in head with steel plates and suitable rubber gaskets held in place with bolts.

(3) Drill and tap into one of the temporary water hole plates for an air hose connection. Apply 30 to 40 psi air pressure with head completely submerged in water heated to 180°—200°F. Over a period of 20 minutes observe for air bubbles which would indicate leaks or cracks in the head.

(4) Replace head if cracks are evident. Replace any leaking injector sleeves.

b. Check water passage running full length of head between valves for restriction. If plugged, open by rodding or drilling.

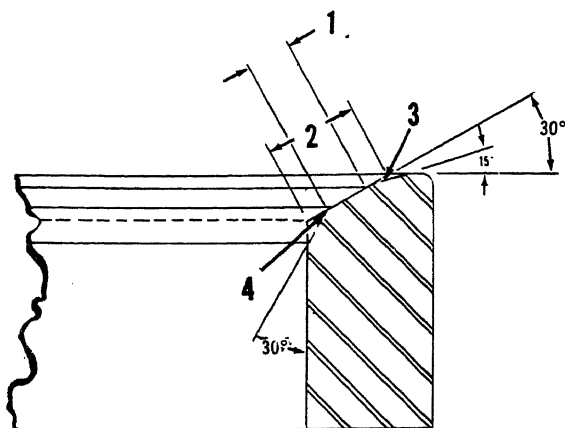
c. Check lubricator oil restrictor plug and lubricating passages.

d. Inspect fuse plug for signs of overheating. If fuse plug has melted, check carefully for further damage to head and engine.

e. Valve seats shall be checked as follows:

(1) Check for loose valve seat inserts by lightly tapping head near inserts. A slight looseness may be found when head is cold and covered with film of oil.

(2) Check seat area width (1 or 2, fig. 14-14). If area width exceeds 0.125 inch at any point, it is unlikely that seat can be successfully reground.



1. MINIMUM SEAT WIDTH 0.063 INCH
2. MAXIMUM SEAT WIDTH 0.125 INCH
3. STOCK REMOVAL POINT
4. STOCK REMOVAL POINT

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Figure 14-14. Valve seat insert, cross section.

(3) If valve seat is loose enough to bounce or cannot be reground, it must be replaced.

f. Check injector sleeves for scratches on cup seat area. Replace if seat area is scratched.

g. Check injector tip protrusion as follows:

(1) Coat injector cup with Prussian Blue, install injector assembly into injector sleeve of head and torque to 11–12 ft-lb (15–16 N·m). Remove injector and check seat pattern. Bluing band must be 0.060-inch minimum in width and located approximately fifteen thirty-seconds of an inch from bottom of head surface.

(2) Measure tip protrusion with a dial indicator. Tip protrusion must be 0.040–0.055 inch.

h. Cross lead guides shall be checked for the following:

(1) With micrometer check outside diameter of guide. If measurement is less than 0.432 inch, replace.

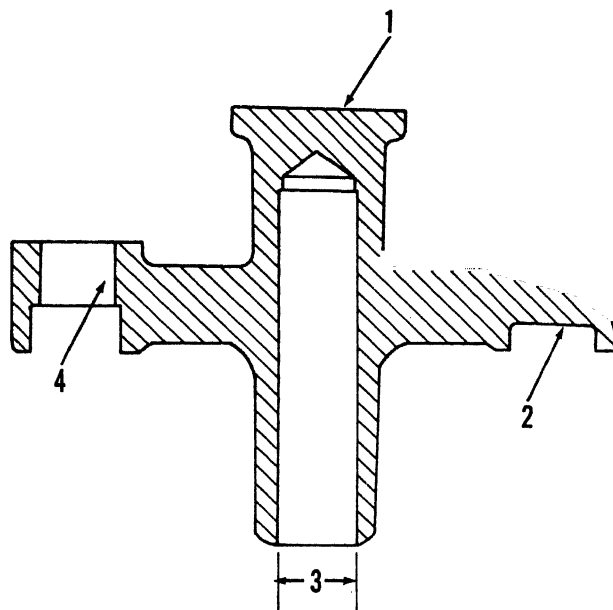
(2) Check guide for straightness. It shall be at right angles with milled surface of head. Replace if not straight.

(3) Check cross head protrusion above cylinder head. Protrusion shall be 1.860 to 1.880 inches.

(4) Check stem inside diameter (3, fig. 14-15)

using a small bore gauge set at 0.4402 inch. Use as a "No Go" gauge to check for wear, beyond worn replacement limit.

(5) Check for wear on rocker level (1) and valve stem contact surface (2). Check adjusting screw and crosshead threads (4) for wear or distortion. Replace if excessive wear is found.



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Figure 14-15. Crosshead dimensions.

(6) Check reamed depth of the crosshead bow, it shall be a minimum of 1.00 inches. The valve stem counterbore depth on underside of crosshead shall be 0.120–0.140 inch.

i. Valve guides shall be checked per the following steps.

(1) Check inside diameter using a small bore gauge set at 0.4547 inch. Use bore gauge as a "No Go" gauge.

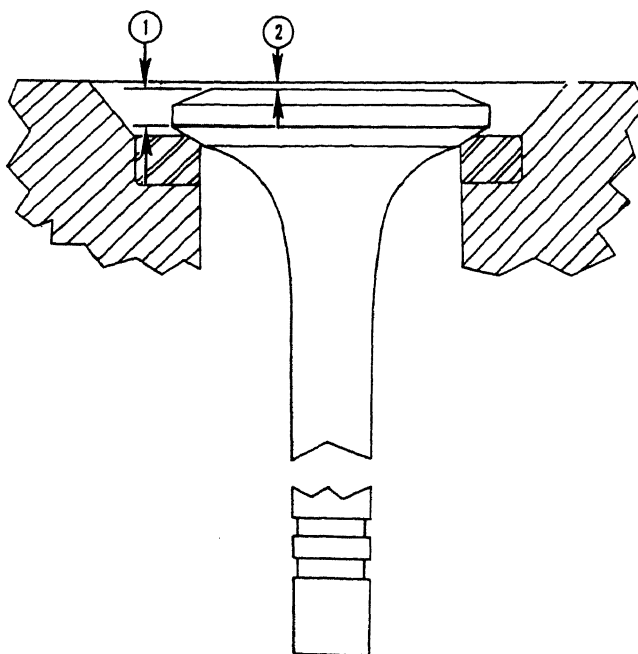
(2) Check for out-of-round holes; gauge at several points crosswise and endwise of head. Check guide for chips, cracks or burrs. Replace any guides with excessive wear or damage.

j. Clean valves with a buffer and polish with crocus cloth. Inspect valves for the following:

(1) Inspect valves for cupped heads, cracked, pitted or worn surfaces. If possible reground within limits.

(2) Check valve for rim thickness. Replace if rim is less than 0.105 inch (1, fig. 14-16).

(3) Check valve stems for scoring or wear beyond worn limits. Replace if stem outside diameter is less than 0.449 inch. New valve stem diameter must be 0.450–0.451 inch.



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Figure 14-16. Valve head rim thickness.

(4) Check wear of collect recesses. Replace if new collets will not fit securely in place.

14-19. Overhaul

a. *Sleeve Eroded Water Holes.* If the area $\frac{1}{16}$ to $\frac{5}{32}$ of an inch from edge of water hole is not free of any erosion, pits, scratches or blemishes which are more than 0.0003 inch deep, the water hole must be sleeved as follows:

(1) Coat sleeve, part No. 191078, with sealant and align in top of water passage hole. With a bushing driver and hammer, drive sleeve into proper position.

(2) File sleeve flush with top of cylinder head. Do not damage head surface. Remove any burrs from inside diameter of sleeve, clean all cuttings from water passages.

(3) If proper sleeve is not available, heavy wall copper tubing may be used. Tubing must provide 0.002- to 0.005-inch press fit. Overall length shall be approximately one-half inch. Inside diameter must be seven-sixteenths of an inch to allow proper water flow.

b. *Resurfacing Cylinder Head.* If cylinder head has been scratched, etched or worn unevenly at point of contact with gasket seating areas, it shall be resurfaced as follows:

(1) Remove 0.005 to 0.006 inch of material at one time and no more than a total of 0.030 inch.

(2) Waviness on mounting surface must not exceed 0.0004 inch in depth with at least 1.00 inches between high and low points. The surfaces shall not deviate from a true plane more than 0.0003 inch within 0.250 inch of any opening and total deviation of less than 0.0004 inch.

(3) Remove an equal amount of stock from the valve seat insert counterbore, as was removed during the head resurfacing operation.

(4) Sand surface of cylinder head with an orbital sander. Do not use a disc sander or allow the sander to tilt or rock.

(5) Using a micrometer or vernier depth gauge check head height. Head height must be more than 5.460 inches.

(6) Check exhaust ports for flatness. Ports shall not be out of plane more than 0.003 inch.

(7) Install new injector sleeves to maintain correct injector tip protrusion.

(8) Check over-all height of assembled valve springs to see if it is necessary to install spacers (one-sixteenth of an inch maximum) under springs to obtain correct assembled height. Only a one thirty-second of an inch thick spacer can be used if head has not been resurfaced.

c. *Regrooving of Cylinder Head.* If the cylinder head

has been resurfaced, it will be necessary to cut grooves in the cylinder head over each cylinder liner sealing area. These grooves will assure a better seal between the cylinder head gasket and block. Groove shall be cut to a depth of 0.006—0.008 inch.

d. Replacement of Valve Guides. Valve guides shall be replaced as follows:

- (1) Worn out valve guides shall be driven out from the underside of the cylinder head.
- (2) Press guides into head to obtain a 1.315- to 1.325-inch protrusion above head surface.

CAUTION

Guides which have been through the "tuff-triding" process, identified by a dull gray appearance, are not to be reamed.

- (3) Insert valve into valve guide and check for freedom of movement. If valve does not move freely, ream valve guide from bottom side of cylinder head with proper reamer to dimensions 0.4525—0.4532 inch.

e. Replacement of Crosshead Guides. Remove crosshead guides with a suitable dowel puller. Press new guides into head until a 1.86- to 1.88-inch protrusion is obtained.

f. Valve Seat Insert. When a seat is worn beyond regrind specifications, a new valve seat insert shall be installed as follows:

WARNING

Cover the valve seat with a shop rag to avoid injury from broken pieces of the seat.

- (1) Remove loose or excessively worn valve seat inserts by striking insert sharply with a chisel, causing it to crack and release the press fit. Remove all inserts if head has been resurfaced.

- (2) Enlarge counterbore to next oversize. Inserts are available in standard and oversizes shown in table 14-2. If head has resurfaced, and standard inserts are to be used, deepen counterbore only.

Table 14-2 Valve seal insert specification

Insert part No.	Diameter	Oversize depth	Insert OD	Cylinder head ID	Insert thickness
127930	STD	STD	2.0025/2.0035	1.9995/2.0005	0.278/0.282
127935	0.010	STD	2.0075/2.0085	2.0045/2.0055	0.278/0.282
127931	0.010	STD	1.0125/2.0135	2.0095/2.0105	0.278/0.282
127932	0.020	0.005	2.0225/2.0235	2.0195/2.0205	0.283/0.287
127933	0.030	0.010	2.0325/2.0335	2.0295/2.0305	0.288/0.292
127934	0.040	0.015	2.0425/2.0435	2.0395/2.0403	0.293/0.297

Note: Dimensions are in inches.

- (3) Cut counterbore 0.006—0.010 inch deeper than insert thickness to permit peening of heat to hold insert. Surface at the bottom of counterbore must be perfectly flat for the insert to seat properly. Remove all chips and dirt.

- (4) Install valve seat insert, and with a one-fourth inch diameter round end punch, peen around insert at least four or five places.

CAUTION

Over-swaging around insert may crack cylinder head.

g. Grinding of Valve Seats. If an old insert is to be refaced, or if a new insert is installed, the work must be done with a grinding wheel using the eccentric method.

- (1) Apply a 30° grinding wheel on the valve insert.
- (2) If seating area (2, fig. 14-14) is wider than one-eighth of an inch, stock can be removed from point "A" with a 15° grinding wheel.

- (3) Check concentricity of each valve seat insert relative to the valve guide with a dial indicator. If run-out exceeds 0.002 inch, check for bent valve guide before regrinding the insert.

- (4) Apply a light coat of Prussian Blue to the valve seat insert. Lower the stem of the valve in the valve guide until the valve mates with the valve seat. Do not

rotate valve. This procedure will indicate the area of contact on the valve face. The most desirable area of contact is at the center of the valve face.

h. Testing of Valve Springs. Test valve springs on a spring tester that is capable of accurate measurements of spring lengths.

- (1) Spacers may be used under valve spring, when insert and valve have been refaced to make valve spring check within load limit. A maximum of one-sixteenth of an inch spacers may be used when head has been resurfaced and valve and seat have been refaced.

- (2) If valve spring compresses to 1.724 inches with less than 145 pounds, it should be discarded.

i. Injector Sleeve. Worn injector sleeves must be replaced.

- (1) Using a "muffler cutting tool" remove injector sleeves.

CAUTION

Extreme caution should be taken not to damage the head surfaces.

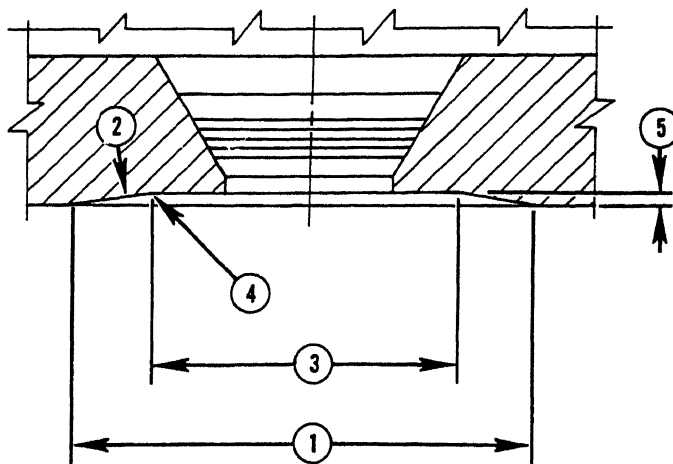
- (2) Remove all foreign material from injector sleeve sealing area.

- (3) If head was resurfaced, restore shallow recess area (1, fig. 14-17) around injector port. With a 3-inch grinding stone dressed to 7° angle (2), grind area (1) to

1.750-inch diameter.

(4) Grind area (3) flat with a diameter of approximately 1.180 inches and 0.030 to 0.040 inch deep (5). A

0.010 to 0.010 to 0.030-inch radius must be present at (4).



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Figure 14-17. Injector recess area.

(5) Place new preformed packing, coated with clean lubricating oil, into groove of injector sleeve bore in head.

(6) Push new injector sleeve into bore of cylinder head until it bottoms. Roll top one-half inch area of injector sleeve.

CAUTION

Over-rolling of injector sleeve will cause deformation of sleeve into packing groove.

(7) Cut injector seat to provide proper seat and injector tip protrusion. Protrusion of injector must be

0.040—0.055 inch when injector is torqued to 11—12 ft-lb (15—16 N · m).

(8) Apply Prussian Blue to injector sleeve. Install injector in cylinder head. Bluing band must be 0.060-inch minimum width, 360° around injector seat.

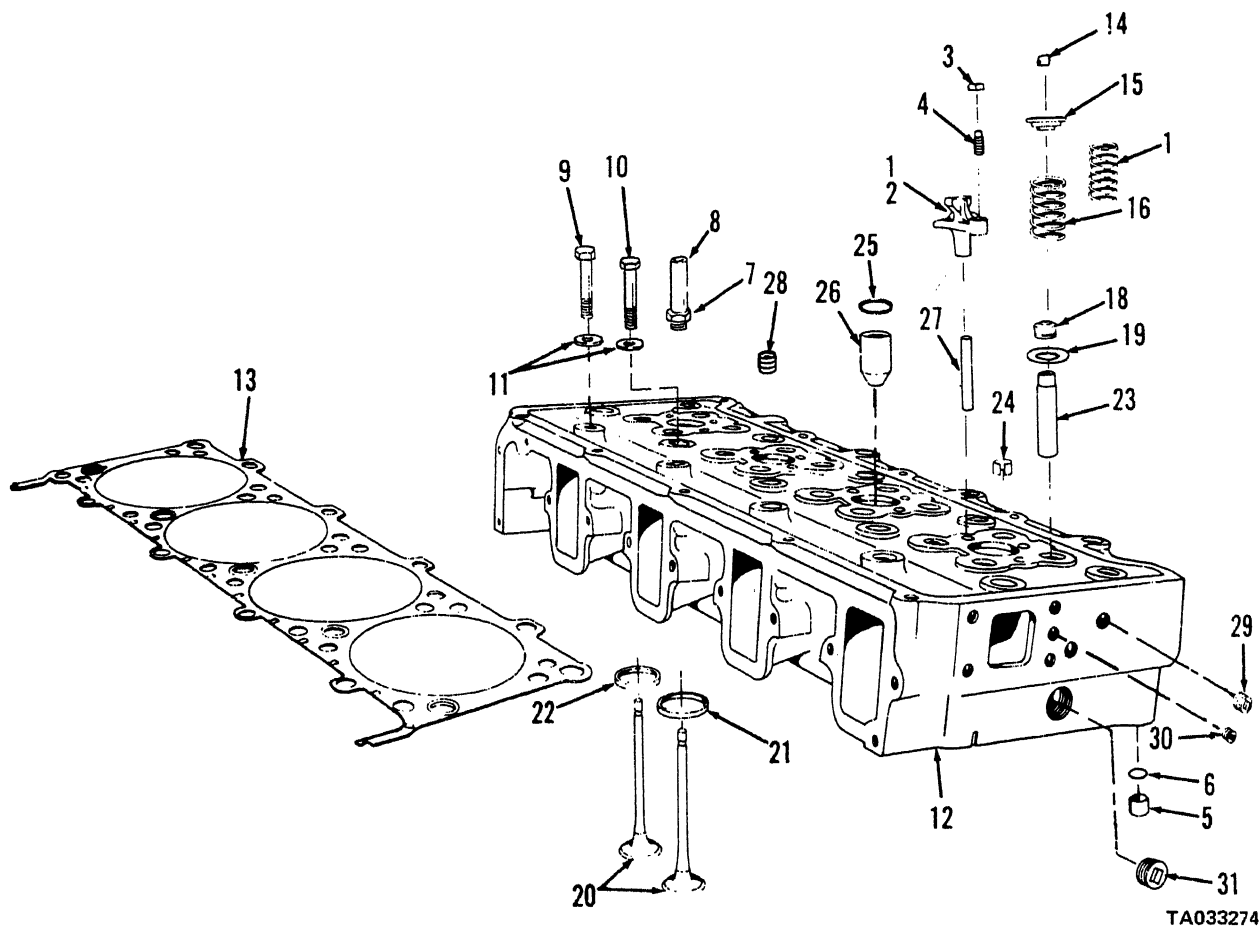
14-20. Reassembly

Refer to figure 14-18.

a. Install pipe plugs (31), (30), (29), and (28) using a good plug sealer or sealing tape. Pipe plugs shall torque as listed in table 14-3.

Table 14-3. Pipe plug torque ft-lb

Plug size	Minimum	Maximum
1/8 inch	5 (6.8 N · m)	10 (13.5 N · m)
Fuse Plug	5 (6.8 N · m)	10 (13.5 N · m)
3/8 inch	35 (47.5 N · m)	45 (61.0 N · m)
1/2 inch	60 (81.3 N · m)	70 (94.9 N · m)
3/4 inch	65 (88.1 N · m)	75 (101.7 N · m)
1 inch	135 (183.0 N · m)	145 (196.9 N · m)



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- 1 Intake crosshead
- 2 Exhaust crosshead
- 3 Crosshead nut
- 4 Adjusting screw
- 5 Dowel
- 6 Preformed packing
- 7 Nut
- 8 Tube connector
- 9 Headbolt
- 10 Headbolt
- 11 Washer

- 12 Cylinder head
- 13 Gasket
- 14 Lock
- 15 Guide
- 16 Outer spring
- 17 Inner spring
- 18 Seal
- 19 Wear plate
- 20 Valve
- 21 Insert

- 22 Insert
- 23 Guide
- 24 Ring
- 25 Preformed packing
- 26 Sleeve
- 27 Guide
- 28 Plug
- 29 Plug
- 30 Plug
- 31 Plug

Figure 14-18. Cylinder head—exploded view.

b. Crosshead guides (27), injector sleeves (26), packing (25), rings (24) valve guides (23), exhaust inserts (22), and intake inserts (21) shall have been installed as described in paragraph 14-19.

c. Lubricate stems of valves (20) with clean engine oil and insert valves (20) in valve guides (23). Temporarily hold valves in place with a strip of masking tape.

NOTE

Valve must be installed in same inserts to which they were checked.

d. Place cylinder head face down on wooden bench or blocks to protect the milled surface.

e. Install wear plates (19) over valve guides. Place plastic sleeve over valve stems and press seals (18) over

stems until properly seated on valve guides. Remove plastic sleeves.

f. Assemble springs (17) and springs (16). Up to $\frac{1}{16}$ -inch spacers may be used to reduce valve spring length if cylinder head has been reground.

CAUTION

Using an excessive amount of spacers will cause the compressed spring to become a solid sleeve.

g. Assemble upper valve guide (15). Compress valve springs using a suitable compressor. Install new locks (14).

14-21. Installation

Refer to figure 14-18.

a. Clean mating surfaces of cylinder block and

cylinder head. Cylinder liner walls shall be clean and well lubricated with clean engine oil.

NOTE

Install tappets as instructed in paragraph 14-15.

b. Install head gasket (13) over ring dowels so word "TOP" on gasket is visible. All bolt holes in the gasket must be aligned with holes in the block.

c. Lift cylinder head (12) with suitable hoist and lower into place over ring dowels.

d. Install washers (11), and headbolts (9) and (10).

Washers and headbolts shall be coated with clean engine oil. Snug tighten headbolts of each head in sequence of figure 14-7.

e. Install tube connector (8, fig. 14-18), and tube nut (7). Install new packing (6) and dowels (5).

f. Place intake and exhaust crossheads (1) and (2) over crosshead guides. Hold crosshead firmly down on mating valve stem. Run crosshead adjusting screw (4) down until it just touches valve stem. Snug tighten locknuts (3).

Section VI. FLYWHEEL, FLYWHEEL HOUSING, GEAR HOUSING AND OIL PAN

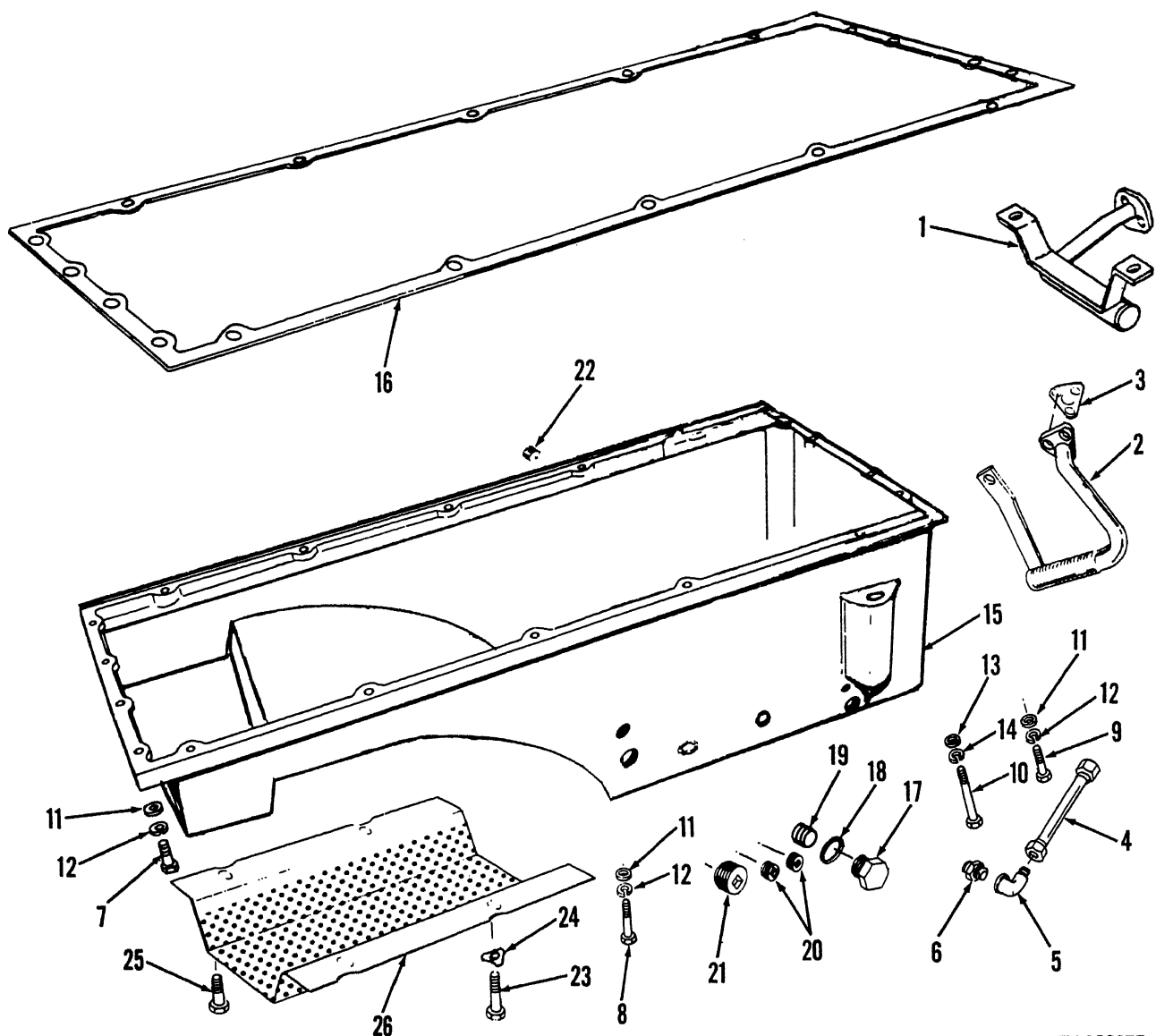
14-22. Removal and Disassembly

a. Refer to figure 14-19. Remove and disassemble the oil pan as follows:

(1) Remove by-pass tube (1), section tube (2), gasket (3), drain back tube (4), elbow (5) and adapter

(6).

(2) Remove screws (7, 8, 9 and 10), washers (11 and 13) lock washers (12 and 14), pan (15), and gasket (16).



TA033275

- 1 By-pass tube
- 2 Suction tube
- 3 Gasket
- 4 Drain back tube
- 5 Elbow
- 6 Adapter
- 7 Screw
- 8 Screw
- 9 Screw
- 10 Screw
- 11 Washer
- 12 Lock washer
- 13 Washer

- 14 Lock washer
- 15 Pan
- 16 Gasket
- 17 Plug
- 18 Gasket
- 19 Insert
- 20 Plug
- 21 Plug
- 22 Plug
- 23 Screw
- 24 Plate
- 25 Screw
- 26 Baffle

Figure 14-19. Oil pan—exploded view.

(3) Remove plug (17) and gasket (18). Remove insert (19) if threads are damaged.

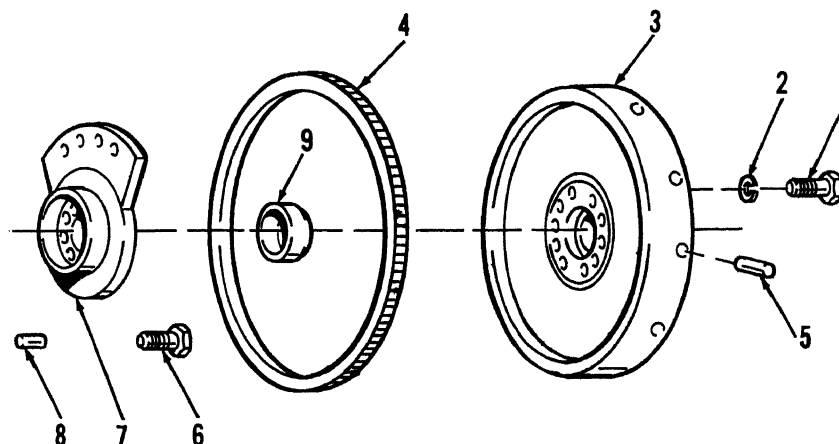
(4) Remove plugs (20), plug (21), and plug (22).

(5) Remove screw (23), plate (24), screw (25) and baffle (26).

b. Refer to figure 14-20. Remove and disassemble

flywheel and flywheel adapter as described.

(1) Remove two screws (1) and lock washers (2) on opposite sides of flywheel. Insert two threaded studs, 6 inches long, in two holes to provide support for flywheel during removal.



TA033276

- 1 Screw
- 2 Washer
- 3 Flywheel
- 4 Gear
- 5 Dowel
- 6 Screw
- 7 Adapter
- 8 Dowel
- 9 Retainer cup

Figure 14-20. Flywheel—exploded view.

NOTE

Insert wooden block between crankshaft and cylinder block to prevent crankshaft from turning while removing capscrews.

(2) Remove remaining screws (1) and lock washers (2). Insert two puller capscrews in holes provided. Turn in capscrews alternately to remove flywheel (3).

(3) If necessary ring gear (4) may be removed. Heat ring gear with a torch. Support the flywheel, crankshaft side down, on a solid flat surface or a hardwood block that is slightly smaller than the inside diameter of the ring gear. Note the chamfer on the gear teeth so that the new gear may be installed in the same position. Drive ring gear (4) from the flywheel with a suitable drift and hammer. Work around the periphery

of the flywheel to avoid binding the gear on the flywheel.

(4) Remove dowel (5) from flywheel.

(5) Remove screws (6) and pull adapter (7) from crankshaft using a suitable puller.

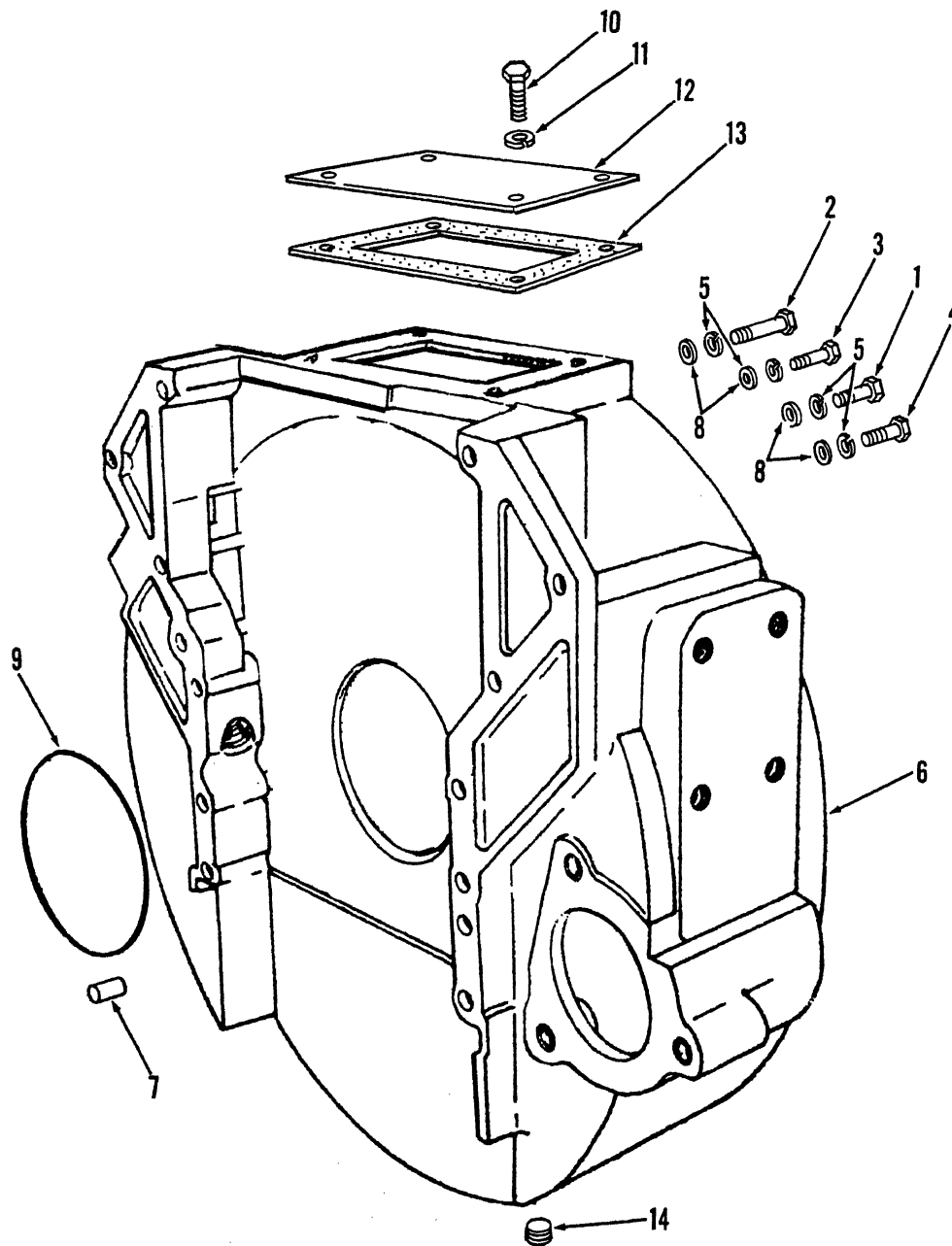
(6) Remove dowel (8) and cup (9) from adapter.

c. Refer to figure 14-21. Remove and disassemble gear housing as follows:

(1) Remove screws (1, 2, 3 and 4), lock washers (5), and pull housing (6). Strike face of housing alternately on each side, with a soft hammer, to loosen.

(2) Remove dowels (7), preformed packing (8), preformed packing (9) and pipe plug (14).

(3) Remove screws (10), lock washers (11), and lift cover (12) from housing. Remove gasket (13).



TA033277

- 1 Screw
- 2 Screw
- 3 Screw
- 4 Screw
- 5 Lock washer
- 6 Housing
- 7 Dowel

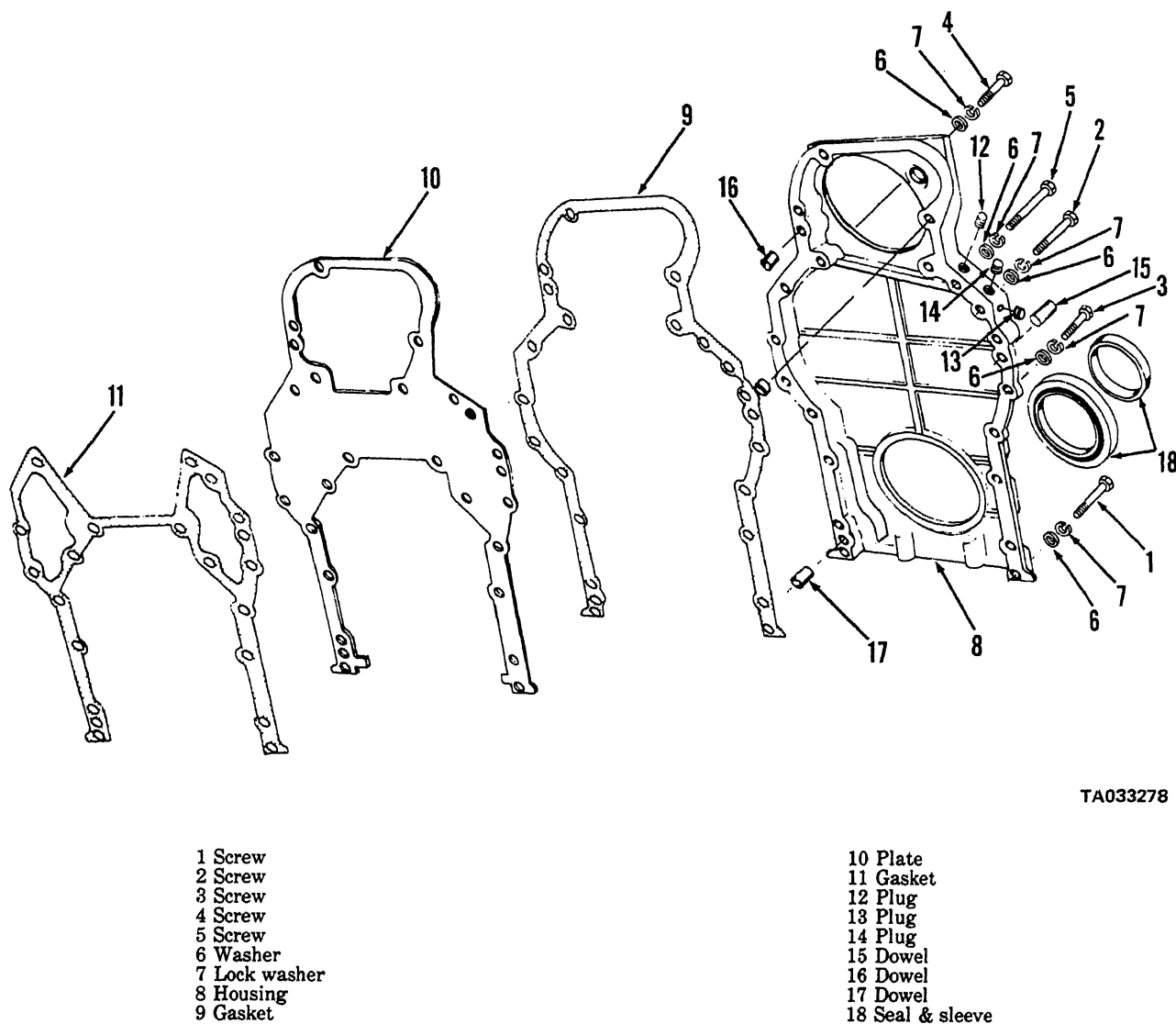
- 8 Preformed packing
- 9 Preformed packing
- 10 Screw
- 11 Lock washer
- 12 Cover
- 13 Gasket
- 14 Plug

Figure 14-21. Flywheel housing—exploded view.

d. Refer to figure 14-22. Remove and disassemble the gear housing as described in the following steps:

(1) Remove screws (1, 2, 3, 4 and 5), washers (6),

and lock washers (7). Remove housing (8), gasket (9), plate (10), and gasket (11).



TA033278

Figure 14-22. Gear housing—exploded view.

(2) Remove plugs (12, 13 and 14), and dowels (15, 16 and 17).

(3) Remove crankshaft oil seal and sleeve (18) from gear housing. Support housing on a flat solid surface or hardwood block during removal.

14-23. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent before inspection.

b. Replace all seals and gaskets.

c. Inspect housings for cracks, breaks, burrs or any other damage. Replace housing if they are damaged.

d. Check flywheel face for signs of cracks, scoring or

overheating.

e. Inspect flywheel ring gear for signs of cracks, missing teeth or excessively worn teeth.

f. Inspect the pan for porosity and cracks. Check for misaligned flanges and raised surfaces surrounding the bolt holes. Repair as necessary.

g. Inspect oil pan mounting screw holes for damaged threads.

h. Inspect all dowels; if worn or sheared, replace.

14-24. Reassembly and Installation

a. Refer to figure 14-22 and install gear housing as follows:

(1) Seal and sleeve (18) shall not be installed in

housing until after housing is mated to block.

- (2) Install dowels (15, 16 and 17) in engine block.
- (3) Install plugs (12, 13 and 14) in gear housing.
- (4) Position gasket (11) and plate (10) to rear of cylinder block and secure. Plate must be flush with bottom of block within 0.000-0.008 inch.
- (5) Trim spacer plate gasket (11) flush to 0.010 inch above pan rail. Hold knife blade flat to avoid cutting gasket below surface.
- (6) Clean housing and spacer plate mating surfaces of dirt, burrs, etc. Check alignment of index marks on camshaft and crankshaft gears.
- (7) Place gasket (9) and housing (8) on block over dowels, secure snugly.
- (8) Place dial indicator on end of crankshaft and check housing seal bore run-out. It must not exceed 0.008 inch. If run-out exceeds limit, remove housing and dowels from block.
- (9) Replace housing (8) and align housing bore. Ream dowel holes for smallest oversize dowel; install new pin dowels (use pin type dowels only for field replacement).
- (10) Repeat paragraphs (7) and (8) above. Remove housing.

(11) Coat oil seal (18) with clean lubricating oil, position seal with open end to inside of housing. Press seal (18) into crankshaft bore from outside of housing until seal is approximately 0.110 inch below outer edge of bore.

CAUTION

Failure to provide adequate support may crack housing.

- (12) Position gear housing over dowels in block. Tighten screws to 30—32 ft-lb (41—44 N • m) torque.
- (13) Trim excess spacer plate to gear housing gasket material flush to 0.010 inch above base of gear housing.

b. Refer to figure 14-21. Assemble and install flywheel housing as described in the following steps.

- (1) Assemble new gasket (13), cover (12) washer (11), and screws (10) to flywheel housing.
- (2) Install plug (14), new packing (8 and 9) and dowels (7) to flywheel housing.

(3) Clean all dirt and burrs from the mating surfaces of cylinder block and flywheel housing (6).

(4) Position flywheel housing (6) to cylinder block. Install washers (5) and screws (1, 2, 3 and 4). Snug tighten screws.

c. Refer to figure 14-20. Assemble and install flywheel adapter in the following method.

- (1) Apply a light coat of heavy oil on inside bore of adapter (7). Lubricate rear oil seal lips with clean

engine oil.

(2) Position adapter to crankshaft. Align dowel holes in crankshaft and adapter with aligning stem.

(3) Using three screws (6) equally spaced, pull adapter onto crankshaft. Turn each screw approximately one-half turn repeatedly until adapter is pulled into operating position. Recheck location of dowel holes with locating stem.

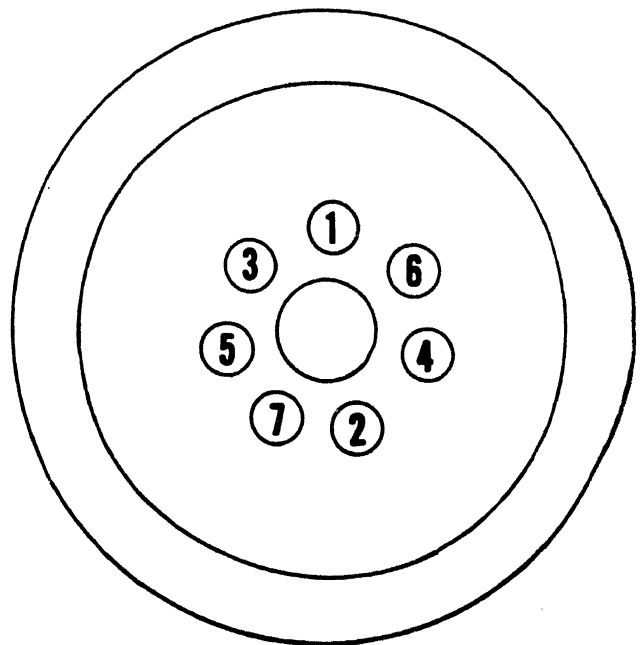
CAUTION

Care must be taken to pull adapter on crankshaft squarely.

(4) Drill and ream dowel holes, to smallest oversize, if either or both a new crankshaft or adapter is used. Reamer must bottom in dowel holes.

(5) Drive in dowels (8), standard or oversize whichever is required, flush or below screws mounting face.

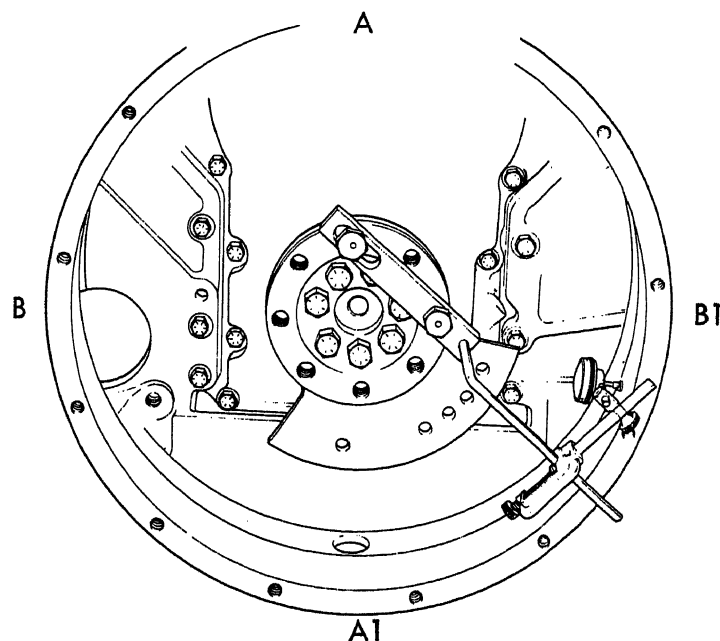
(6) Install screws (6); torque in 75 ft-lb (101.7 N • m) increments to 340—350 ft-lb (461—475 N • m). Torque in sequence shown in figure 14-23.



TA033279

Figure 14-23. Flywheel adapter torquing sequence.

- (7) Check flywheel adapter run-out. Mark housing at A, A1, B and B1 as shown in figure 14-24.



TA033280

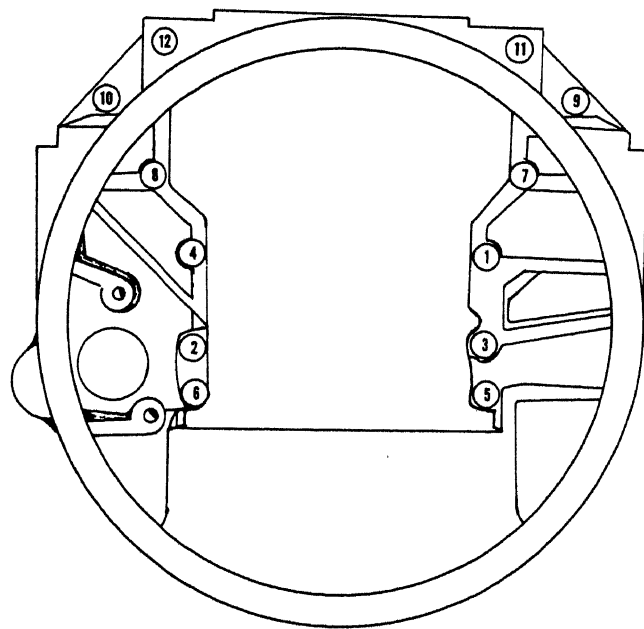
Figure 14-24. Run-out flywheel housing bore.

(8) Check readings at B and B1. If total run-out exceeds 0.010 inch, use a pinch bar to move housing one-half of the total indicator reading to center housing horizontally.

(9) Check readings at A and A1. If total run-out exceeds 0.010 inch, remove dowel and pry housing either up or down one-half of the total reading to center vertically.

(10) Recheck, until both the horizontal (B and B1) and vertical (A and A1) are within limits without adjustment to housing.

(11) Tighten screws (1, 2, 3 and 4, fig. 14-21) alternately to 30–35 ft-lb (41–48 N·m) torque. Torquing sequence is shown in figure 14-25.



TA033281

Figure 14-25. Flywheel housing torque sequence.

(12) Recheck run-out readings.

(13) Check flywheel housing face run-out. If total face run-out exceeds 0.008 inch, remove housing and recheck mating surfaces. Reinstall housing, realign dowel and retorquer screws per paragraph (11).

d. Refer to figure 14-19. Assemble and install oil pan as described in the following:

(1) Install baffle (26), screw (25), plate (24) and screws (23). Install plugs (22), plugs (21) and plugs (20).

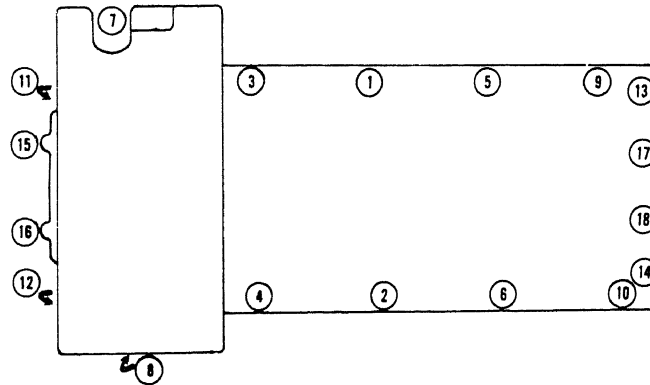
(2) Install new insert (19), gasket (18) and drain

plug (17).

(3) Check pan to block mating surface to insure all nicks and burrs have been removed. Install gasket (16) into position on pan.

(4) Position oil pan (15) to block. Pan (15) must be aligned properly to block to prevent leakage.

(5) Install washers (11 and 13), lock washers (12 and 14) and screws (7, 8, 9 and 10). Tighten all screws evenly to 25–30 ft-lb (33–41 N · m) torque. Torquing sequence is shown in figure 14-26.



TA033282

Figure 14-26. Oil pan torquing sequence.

(6) Install adapter (6), elbow (5) and tube (4) to the oil pan.

(7) Install gasket (3) and suction tube (2) to the oil pan.

(8) Install by-pass tube (1).

e. Refer to figure 14-20. Assemble and install flywheel as follows:

(1) Rest ring gear (4) on a flat metal surface. Heat gear uniformly with a torch, keeping the torch moving around the gear to avoid hot spots.

CAUTION

Do not heat the ring gear over 400°F. Excessive heating may destroy the original heat treatment.

(2) Using a suitable tool, place ring gear (4) on

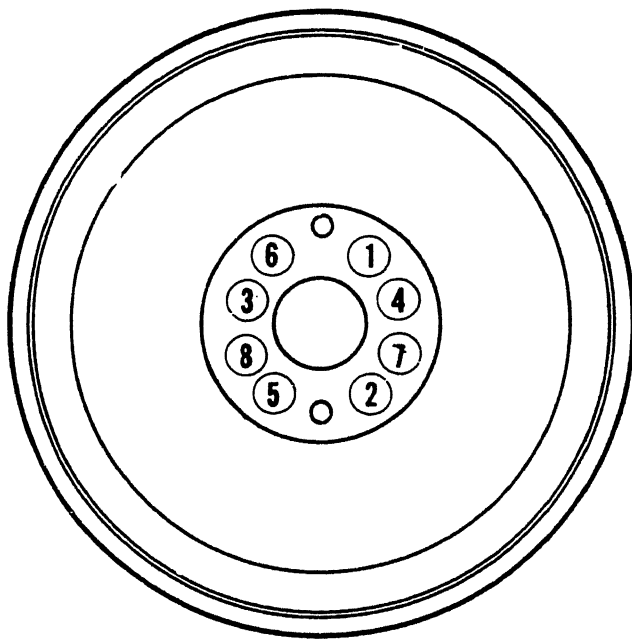
flywheel (3) with chamfer facing the same direction it did originally.

(3) Tap gear in place against the shoulder of the flywheel. If gear does not readily tap into place, remove and reheat the ring gear.

(4) Install retainer cup (9) into adapter (7) bore. Install two guide studs in adapter (7).

(5) Coat screw threads with clean engine oil. Screw head bearing surfaces and hardened washers shall be coated with 140 wt. oil.

(6) Position flywheel (3) over adapter guide studs. Install washers (2) and screws (1). Tighten in sequence shown in figure 14-27 in 50–60 ft-lb (67–81 N · m) increments to a final torque of 200–210 ft-lb (271–285 N · m).

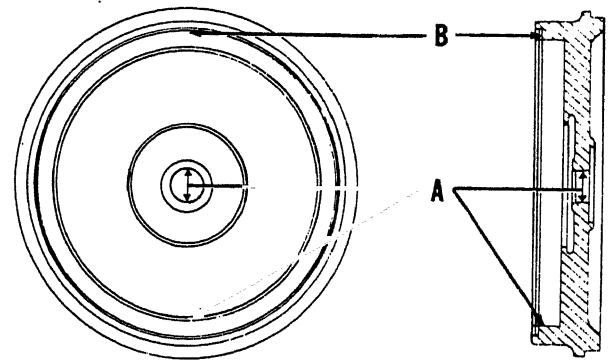


TA033283

Figure 14-27. Flywheel torquing sequence.

(7) Check flywheel bore total run-out. Total run-out must not exceed 0.005 inch. (A, fig. 14-28).

(8) Check run-out of clutch mounting face. Mark four equidistant points on flywheel circumference. Total run-out of these points must not exceed 0.0005 inch per inch of diameter (B, fig. 14-28).



TA033284

Figure 14-28. Flywheel bore and clutch-face check points.

(9) If run-out exceeds limits, remove flywheel and clean flywheel and adapter mating surface. Reinstall flywheel; recheck bores and face.

(10) Remove guide studs, install screws and torque as described in paragraph (6) above.

Section VII. CAM SHAFT AND FRONT COVER

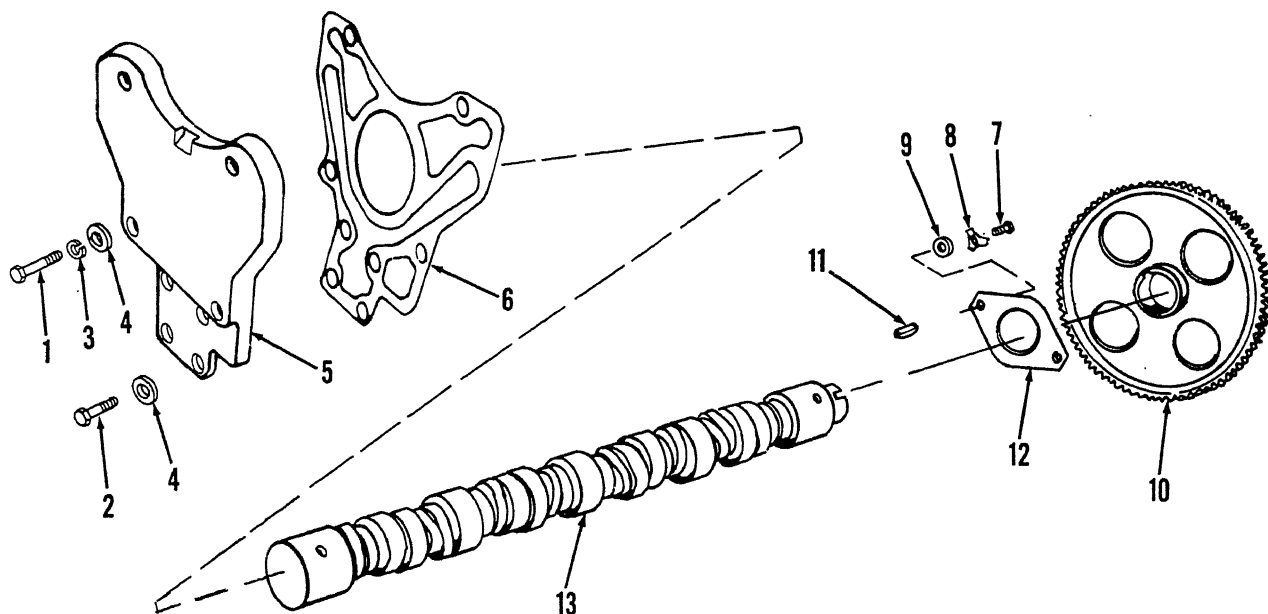
14-25. Removal and Disassembly

a. Refer to figure 14-29. Remove and disassemble camshaft as follows:

(1) Remove capscrews (1 and 2), lockwashers (3) and washers (4). Remove cover (5) and gasket (6).

(2) Straighten lockplates (8), remove screws (7), plates (8) and washers (9).

(3) Rotate gear (10) and lift slightly while removing camshaft (13) from block.



TA033285

- 1 Capscrew
- 2 Capscrew
- 3 Lockwasher
- 4 Washer
- 5 Cover
- 6 Gasket
- 7 Capscrew
- 8 Lockplate
- 9 Washer
- 10 Gear
- 11 Key
- 12 Thrust plate
- 13 Camshaft

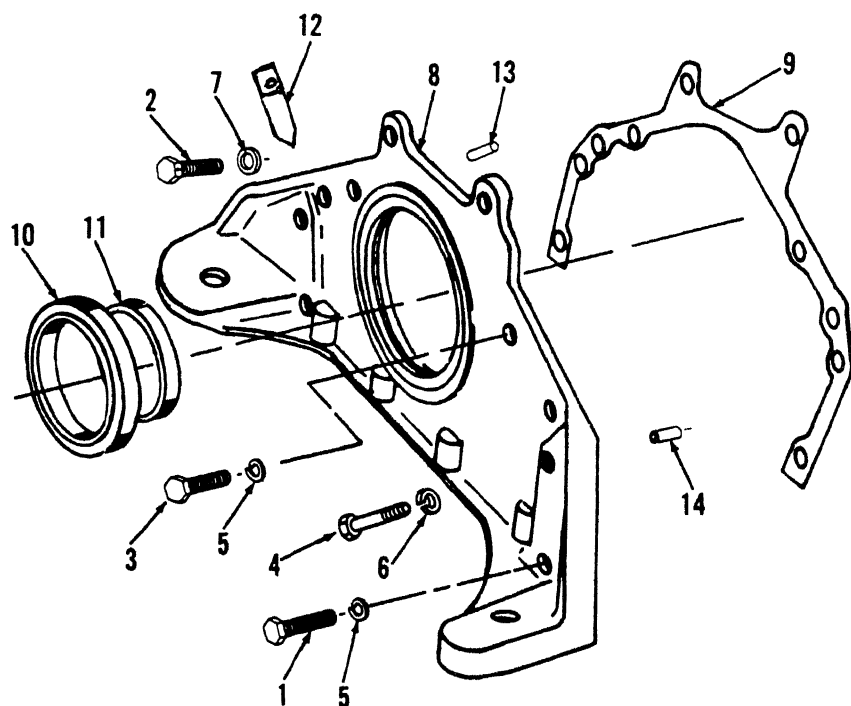
Figure 14-29. Camshaft and camshaft cover—exploded view.

(4) Remove gear (10) from camshaft (13) only if gear or thrust plate (12) is damaged (see para 14-26).

b. Refer to figure 14-30. Remove and disassemble front cover as follows:

(1) Remove screws (1, 2, 3 and 4), lock washers (5 and 6), and washers (7).

(2) Pull cover (8) and gasket (9) from the cylinder block.



- 1 Screw
- 2 Screw
- 3 Screw
- 4 Screw
- 5 Lock washer
- 6 Lock washer
- 7 Washer

- 8 Cover
- 9 Gasket
- 10 Seal
- 11 Sleeve
- 12 Pointer
- 13 Dowel
- 14 Dowel

TA033286

Figure 14-30. Front cover—exploded view.

(3) Remove seal (10), sleeve (11), pointer (12), dowel (13) and dowel (14).

14-26. Cleaning, Inspection and Repair

a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent, before inspection.

b. Replace seals and gaskets.

c. Inspect cover for cracks or damage. Replace cover if damaged.

d. Using a micrometer check camshaft bushing journals. If journals diameter is less than 2.494 inches, replace camshaft.

e. Inspect camshafts for scuffed, scored, or cracked injector or valve lobes. Replace camshaft if lobes are damaged.

f. Remove camshaft gear if thrust plate is scored or worn or if gear is chipped, cracked or worn.

g. Check thrust plate for flaking, burrs, distortion and wear. Replace if damaged or worn smaller than 0.120 inch.

14-27. Reassembly and Installation

a. Refer to figure 14-29. Assemble and install camshaft as follows:

(1) If gear (10) has been removed, cut a spacer from 0.003-inch shim stock using thrust plate (12) as a template. Cut spacer in half.

(2) Coat camshaft thrust plate with lubriplate type 130-AA or equivalent. Place thrust plate (12) on camshaft (13).

(3) Coat camshaft gear hub area with lubriplate Type 130-AA or equivalent. Place two-piece 0.003-inch shim on top of thrust plate on gear side.

(4) Heat gear (10) to 400°F. Place gear in oven or use heating torch.

(5) Install key (11). Using a pair of tongs, place gear on camshaft hub and press until contact is made with the 0.003 inch-shim. Remove shims and allow gear to cool.

(6) Coat camshaft lobes and journals with clean engine oil. Install camshaft (13) in block, rotate and lift slightly to assist in installation. Care must be taken not to distort cam lobes or journals.

NOTE

Timing must be checked when a new camshaft or gear is installed in an engine.

(7) Align "0" mark on camshaft gear with "0"

mark on crankshaft gear to obtain correct timing.

(8) Install washers (9), lockplates (8), and capscrews (7). Tighten screws to 30—32 ft-lb (41—43 N · m) torque. Bend lockplates.

(9) Install gasket (6) and cover (5). Secure with washers (4), lockwashers (3) and capscrews (1 and 2).

NOTE

Block must be in upright position when checking camshaft end clearance and gear backlash.

(10) Using a dial indicator check camshaft end clearance. It must be 0.007—0.011 inch. If end clearance is not within limits, remove camshaft and adjust gear or change thrust plate.

CAUTION

Never adjust end clearance by striking a cold gear in an attempt to move gear on the shaft hub. Gear must be heated to 400°F. for removal or adjustment.

(11) With a dial indicator check gear train backlash. Backlash shall be 0.004—0.105 inch.

b. Refer to figure 14-30. Assemble and install front

cover as follows:

(1) Install dowels (13 and 14) in cylinder block.

(2) Position gasket (9) and cover (8) over dowels in block. Install lock washers (6 and 5) and screws (1, 3 and 4), snug tighten only.

(3) Install pointer (12) with washers (7) and screws (2). Snug tighten only.

(4) Attach dial indicator gauge to crankshaft flange. Rest pointer inside front cover bore. Rotate crankshaft and check total indicator reading. Run-out must not exceed 0.005-inch maximum.

(5) Check alignment of front cover bottom to cylinder block. Bottom face of front cover must be flush with oil pan flange on block within ± 0.006 inch. Tighten all screws.

(6) Clean sleeve (11) area and apply a light coat of clean engine oil. Install sleeve (11) on crankshaft, with outer beveled end of sleeve facing front cover.

(7) Coat bore of cover and oil seal lips with clean engine oil. Position seal with open lip to inside of cover. Drive new seal (10) in cover.

Section VIII. LUBRICATING OIL PUMP

14-28. Removal and Disassembly

a. Refer to figure 14-31. Remove oil pump as described in the following steps:

(1) Remove suction tube and oil by-pass tube (see para 14-22a).

(2) Remove screws (1), screws (2), and screws (3) and lockplate (4). Remove oil pump.

b. Disassemble oil pump in the following method.

(1) Remove screws (5) and cover plate (6) from cover (28).

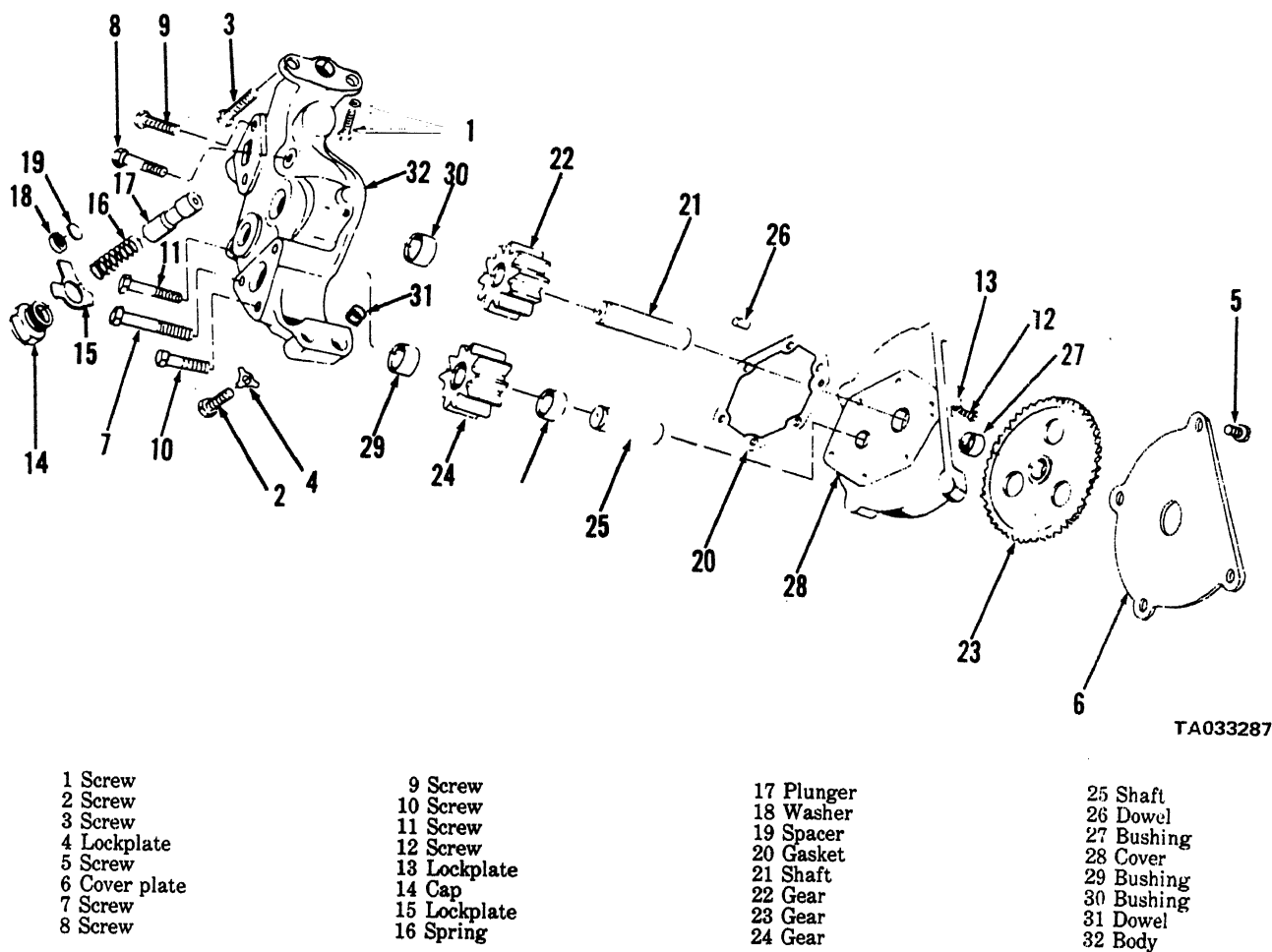
(2) Remove screws (7, 8, 9, 10 and 11). Straighten lockplate (13). Remove screws (12) and lockplate (13).

Separate as an assembly cover (28), shaft (21), gear (22), and gear (23).

(3) Straighten lockplate (15) and remove cap (14), lockplate (15), spring (16), plunger (17), washer (18) and spacer (19).

(4) Remove gasket (20). Support cover (28) in V-blocks on an arbor press. Press shaft (21) through gear (22), cover (28), and gear (23).

(5) Remove gear (24) from shaft (25) in pump body (32). With a suitable puller remove shaft (25) from body (32).



TA033287

Figure 14-31. Lubricating oil pump—exploded view.

(6) If required per paragraph 14-29, remove dowel (26) and bushing (27) from cover (28).

(7) If required per paragraph 14-29, remove bushing (29) from gear (24). Remove bushing (30) and dowel (31) from body (32) if they exceed wear limits. (See paragraph 14-29.)

14-29. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent, Federal Standard P-D-680, or equivalent before inspecting. Dry with compressed air.

b. Replace gasket (20), fig. 14-31).

c. Inspect all pump gears. Replace if teeth are chipped, cracked, scored or show excessive wear.

d. Inspect gear pockets of body. If finished surfaces are damaged or worn excessively, replace body.

e. Measure bushing (29) in idler gear (24). Replace if bushing inside diameter is greater than 0.8785 inch.

f. Inspect drive shaft (21). Replace if rough or outside diameter is worn smaller than 0.874 inch.

g. Inspect idler shaft (25). Replace if rough or outside diameter is worn smaller than 0.875 inch.

h. Measure bushings (27 and 30) in body and cover. If inside diameter is larger than 0.8787 inch, replace bushing.

14-30. Assembly and Installation

a. Refer to figure 14-31. Assemble oil pump as follows:

(1) Install dowel (31) into body (32) if removed.

(2) Press new bushing (30) flush to 0.020 inch below outside surface of body (32).

(3) If required, press new bushings (29) in gear (24) to 0.005—0.015 inch below surface from each end of gear.

NOTE

New bushing in body shall be bored to 0.8767-0.8777 inch. New bushings in idler gear and cover must be bored to 0.8770-0.8775 inch.

(4) If required, press new bushing (27) in cover (28) flush to 0.020 inch below outside surface.

(5) Press shaft (25) into pump body (32) to 0.430-0.460 inch above cover mounting face (1, fig. 14-32).

(6) Press shaft (21, fig. 14-31) in gear (22). Shaft must protrude from end of gear 0.540-0.570 inch (2, fig. 14-32).

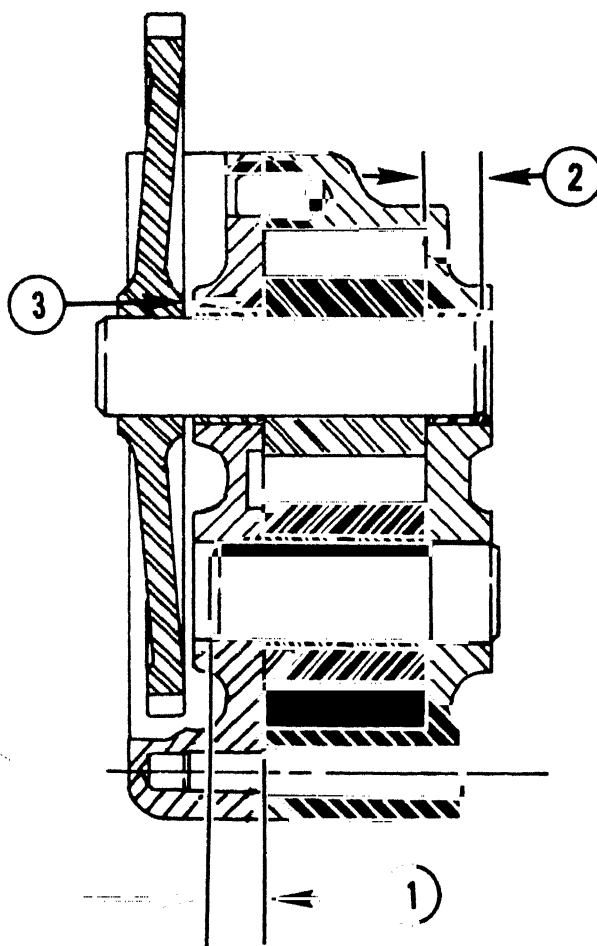
(7) Slide gear (24, fig. 14-31) on shaft (25) into

pump body (32).

(8) Install gear (22) and shaft (21) in pump body (32); place new gasket (20) on body and install cover (28), secure with lockplates (13) and screws (12). Install screws (7, 8, 9, 10 and 11).

(9) With a dial indicator, check for 0.0035-0.0075 inch end clearance on pump drive shaft. Bend lockplates (13) to lock screws (12).

(10) Support drive shaft and press gear (23) on shaft (21). Maintain a clearance of 0.030-0.060 inch between gear hub face and cover face (3, fig. 14-32).



TA033288

Figure 14-32. Lubricating oil pump assembly dimensions.

(11) Position cover (6, fig. 14-31) to pump cover and secure with screws (5). Using a center punch, stake edge of screws to lock screws in place.

(12) Install plunger (17), spring (16); secure with

lockplate (15) and cap (14). Bend lockplate to lock cap.

b. Install lubricating pump in the following manner.

(1) Position lubricating oil pump and suction tube assembly to block engaging pump drive gear in

crankshaft drive gear. Install screws (1, 2 and 3) and lockplates (4). Tighten screws to 20—25 ft-lb (27—34 N · m) torque.

(2) Check pump drive gear backlash, it must be

0.004—0.016 inch. If not within limits, gear train must be replaced.

(3) Bend lockplates (4) to secure mounting screws.

Section IX. VIBRATION DAMPER, CONNECTING RODS AND PISTONS

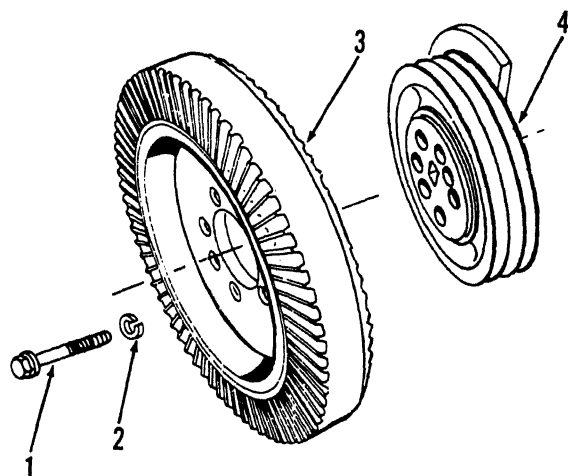
14-31. Removal and Disassembly

a. Refer to figure 14-33. Remove vibration damper as follows:

- (1) Remove screws (1) and lock washers (2).
- (2) Using a suitable puller, remove damper (3).

CAUTION

Pounding or prying must not be resorted to in removing the damper.



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1 Screw
2 Lock washer

3 Damper
4 Pulley

Figure 14-33. Vibration damper—exploded view.

(3) Remove crankshaft pulley (4).

b. Refer to figure 14-34. Remove and disassemble connecting rods and pistons as follows:

(1) Straighten lockplates (2). Remove nuts (1), lockplates (2), and screws (3). Remove connecting rod cap, cap must be stamped or labeled to mate with same rod (4).

(2) Remove bearing shells (5). Tape mating shells together and label by cylinder.

(3) Turn block and clean all carbon from upper inside wall of each cylinder liner with fine emery cloth. Clean area thoroughly with compressed air.

(4) Remove piston assemblies. Use care not to damage cylinder liners as pistons and connecting rods are withdrawn.

NOTE

Each rod and cap must be stamped or labeled by cylinder as removed.

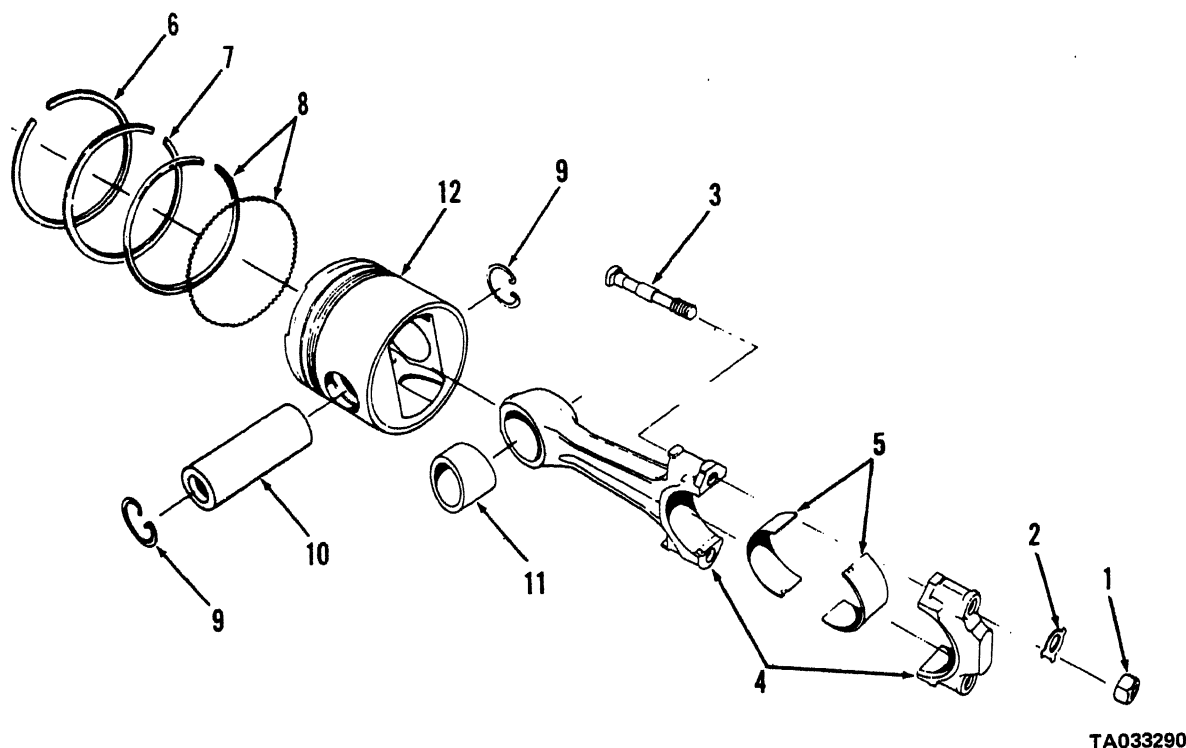
(5) Reassemble each connecting rod cap to mating rod.

(6) Using a suitable ring expander, remove compression ring (6), intermediate ring (7), and bottom ring (8) from piston (12).

(7) Remove snap rings (9). Heat pistons in boiling water, push pin (10) from piston with thumb pressure.

CAUTION

Driving pins (10) from pistons will distort bore and necessitate scrapping of piston.



- 1 Nut
- 2 Lockplate
- 3 Screw
- 4 Connecting rod
- 5 Bearing shell
- 6 Compression ring
- 7 Intermediate ring
- 8 Bottom ring
- 9 Snap ring
- 10 Pin
- 11 Bushing
- 12 Piston

Figure 14-34. Connecting rod and piston—exploded view.

(8) If required, remove bushing (11) from connecting rod (4).

14-32. Cleaning and Inspection

a. Clean all metal parts with cleaning solvent Federal Standard P-D-680 or equivalent before inspecting. Dry with compressed air.

b. Rubber element damper should be cleaned in mild detergent.

CAUTION

Use of solvent or degreasing compounds will cause deterioration of rubber in damper.

c. Inspect vibration damper as follows:

(1) Check rubber element for cracks and elastic member for deterioration. Replace if damaged.

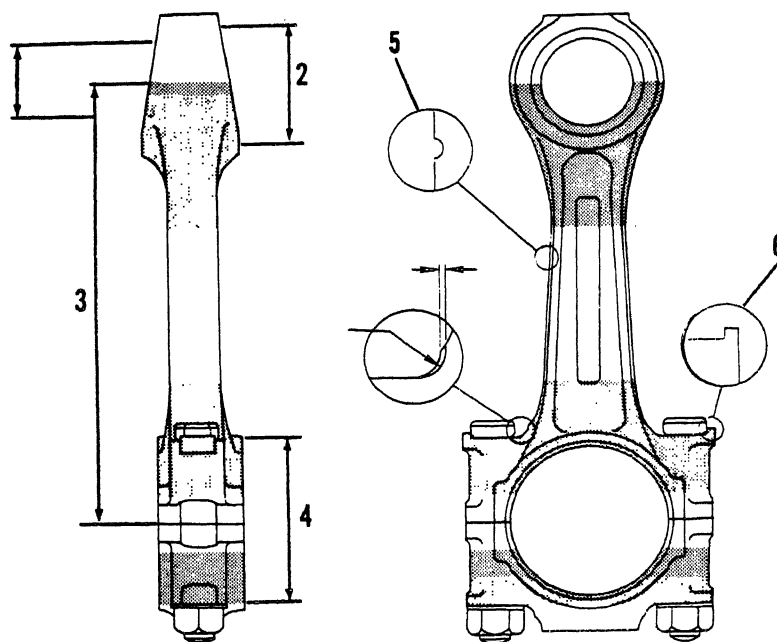
(2) Check alignment of index marks on damper hub and inertia member. If more than one-sixteenth of an inch out of alignment, replace damper.

d. Inspect connecting rods as follows:

(1) Check connecting rods, caps and bolts by magnetic inspection for cracks. Special attention must be shown to the shaded critical areas shown in figure 14-35. If cracks are detected replace rod and cap as an assembly.

(2) With inside micrometer check inner diameter of piston pin bushing. If bore diameter exceeds 1.7525 inches, replace bushing (1, fig. 14-35).

(3) Check connecting rod alignment. Rod length center to center shall be 8.1920—8.1940 inches (3, fig. 14-35).



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Figure 14-35. Connecting rod specifications.

(4) Check crankpin bore. Bore inside diameter must be 3.3158—3.3168 inches. Out-of-round limits shall not exceed 0.0015 of an inch (4, fig. 14-35). If either dimensions is not met, rod must be resized.

(5) Check rod bolts. Discard bolts if smallest diameter is less than 0.478 inch or if pilot diameter is less than 0.5637 inch. Discard all bolts and nuts that have distorted threads.

(6) Assure that bolt head rests squarely on milled surfaces on rod.

(7) Check rod hole pilot inside diameter in rod and cap. If diameter exceeds 0.5645, discard rod and cap.

(8) Check rod bearing shell thickness, discard shells that are less than 0.09295 inch.

e. Inspect pistons as follows:

(1) Check for ring groove clearance. Hold new ring flush with piston land and insert 0.006-inch feeler gauge. If gauge enters groove without forcing or disengaging ring, wear is excessive and piston must be replaced.

(2) Check piston ring gap by inserting each ring in mating cylinder liner, seating it squarely with piston head in ring travel area of liner. Measure ring gap with a feeler gauge. Gap shall be 0.017—0.027 inch for top ring, 0.013—0.023 inch for intermediate ring and 0.010—0.020 inch for lower ring. If necessary, file end of rings to obtain minimum gap.

CAUTION

Never file chrome plated piston rings.

(3) Check piston skirt diameter with micrometers at right angles to piston pin bore. Skirt diameter shall be a minimum of 5.485 inches when measured at 70°F.

(4) Check piston pin bore and piston pin outside diameter. Piston pin bore shall not exceed 1.750 inches. Piston pin diameter shall not be less than 1.7478 inches. Piston pins shall not be reused if out-of-round more than 0.001 inch.

NOTE

Reboring of piston pin bores and use of oversized pins is not practical because the misalignment will cause seizure of piston or failure of connecting rod bearings.

14-33. Repair

a. Damper is not subject to repair, if inspection shows it to be defective; install new damper.

b. A minimum fillet must be present at all corners where rod is milled for bolt head. A sharp corner at bolt pad will contribute to rod breakage (see fig. 14-35).

(1) Piston fillets by milling bolt pad radius to 0.250-0.270 inch and the seat radius to 0.046—0.060 inch.

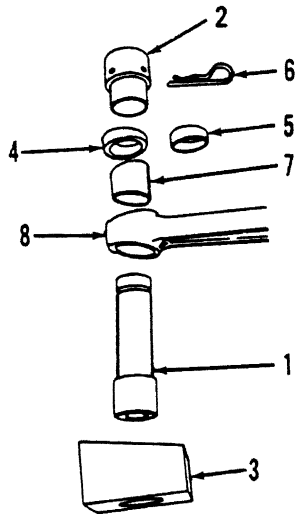
(2) Nicks or dents less than one-sixteenth of an inch deep shall be removed by grinding with a one-half

inch radius wheel or by filing with a half-round file at ends of cut or dent.

c. Replace worn tapered piston pin bushing in the following manner.

(1) Remove bushing with a suitable removal tool. See figure 14-36 for typical tooling.

(2) Assemble tapered bushing (7) on mandrel (1), position sleeve (4) and cup (2) on mandrel (1). Secure with pin (6).



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Figure 14-36. Typical installation of piston pin bushing in rod.

(3) Place connecting rod on block (3) and support in horizontal position.

(4) Insert mandrel into connecting rod bushing bore. Align detail (4) with middle boss on rod. Oil holes must be properly lined up at this time.

(5) Using an arbor press, press bushing into bore until detail (4) contacts side of rod pin boss.

d. Bore rod piston pin bushing after installation in rod. The inside diameter of replacement bushing is smaller than the final diameter's therefore, final reaming is necessary as follows:

(1) Fill lubricating holes with soap to keep out shavings.

(2) Using a Topin-Arp boring machine or equivalent, bore bushing to 1.751—1.7515-inch inside diameter. Check size with a plug gauge.

(3) Remove sharp edges with a scraper.

(4) Remove shavings and soap. Thoroughly clean and dry with compressed air. Recheck all critical dimensions on rebushed and rebored rods.

NOTE

All connecting rods used in an engine should have the same part number and letter code. Never attempt to interchange caps.

e. Tapered piston pin bushing bore must be chamfered to a uniform 0.040—0.60-inch depth on both sides of bore.

14-34. Assembly and Installation

a. Refer to figure 14-34. Assemble and install the connecting rod and piston assembly as follows:

(1) Be sure the same part number piston is used throughout the engine to eliminate weight effect on engine operation.

(2) Install one piston snap ring (9) in groove of piston (12) pin bore.

(3) Heat aluminum piston in boiling water or in an oven at or below 210°F. Install pin (10) through piston (12) and connecting rod pin bore before piston cools.

(4) Install second snap ring (9) on opposite end of piston (12) pin bore.

(5) Install piston rings with a suitable ring expander, starting on bottom of piston, install oil ring expander (8) and oil ring (8). Expander ring ends must not overlap.

(6) Install intermediate (7) and top compression ring (6). Ring gaps must be staggered so they are not in line with each other or piston pin.

CAUTION

Piston rings must not be expanded more than eight times radial thickness during installation. Over expansion may lead ring to breakage or failure to seal.

(7) Remove nuts (1), lockplates (2) and connecting rod cap from bolts (3). Make certain bolt heads are seated squarely on rod shoulder. These parts are not interchangeable.

NOTE

Make sure rods and caps are stamped with cylinder number before removing.

(8) Turn engine to vertical position on engine stand. Rotate crankshaft, so rod journal for cylinder being worked on is at bottom center position. Journal must be free of dirt particles. Place thin plastic tubing over connecting rod bolts threads before inserting assembly in cylinder.

(9) Lubricate rings and piston with clear engine oil. Compress rings with a suitable ring compressor.

NOTE

Do not force rings to compress. Ends of expander could be overlapped. Remove compressor and correct.

(10) With ring compressor in place, insert piston and rod assembly in cylinder. Place numbered side of rod toward outside of block.

NOTE

Position connecting rod so that chamfer of crankpin bore mates with crankshaft fillet.

(11) With a clean plastic tipped pushing tool, push piston and rod assembly through ring compressor until

rings seat in liner. Do not force piston in liner.

CAUTION

Improper use of ring compressor will cause ring breakage. If band-type compressor is used, make certain inner band does not slip down and bind piston.

(12) Pull rod to journal with the connecting rod bolts. Coat rod bearing shell with clean engine oil and roll shell (5) into rod. Shell locking tang must fit in milled recess. Insure that oil holes in rod and shell are properly aligned.

(13) Coat lower shell (5) with clean engine oil and seat in cap with locking tang in place. Install rod cap over bolts (3) so numbered side of cap is matched with numbered side of rod.

(14) Lubricate threads of bolts (3) with clean engine oil. Coat lockplates (2) with 140 w lubricant. Install lockplates (2) and nuts (1). Tighten both nuts (1) in the following method:

(a) Tighten to 50—60 ft-lb (67.8—81.3 N·m)

(b) Tighten to 90—100 ft-lb (122.0—135.6 N·m)

(c) Loosen completely to remove all tension.

(d) Tighten to 30—40 ft-lb (40.7—54.2 N·m)

(e) Tighten to 60—70 ft-lb (81.3—94.9 N·m)

(f) Tighten to 95—105 ft-lb (128.8—142.4 N·m)

(15) Bend tongs on lockplates (2) to secure nuts (1).

(16) Repeat steps 5 through 15 to install piston and rod assembly opposite the one completed. Secure rod to the same crankshaft journal.

(17) Check rods for freeness and side clearance. If rod is not free, loosen cap and check for dirt or burrs. Secure cap as described in paragraph (14) above.

(18) Check for clearance between rods with feeler gauge at three locations around crankshaft. Clearance must be 0.005—0.015 inch.

b. Refer to figure 14-33. Install vibration damper as

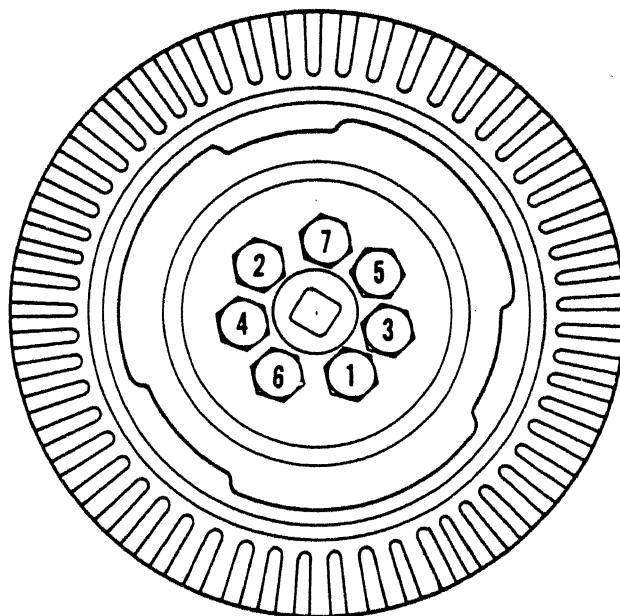
described below.

(1) Damper and crankshaft pulley shall be installed after engine has been assembled and water pump installed.

(2) Position crankshaft pulley and adapter (4) to crankshaft aligning screw holes.

(3) Position vibration damper (3) to crankshaft pulley and align screw holes.

(4) Install lock washers (2) and screws (1). Tighten in sequence shown in figure 14-37.



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Figure 14-37. Vibration damper torquing sequence.

(5) With a dial gauge mounted to front cover, check vibration damper eccentricity and wobble. Run-out must not exceed 0.030 for both checks.

Section X. CRANKSHAFT AND CYLINDER BLOCK

14-35. Removal and Disassembly

a. Refer to figure 14-38. Remove crankshaft as follows:

(1) Remove bearing screws (1), bearing screws (2), washers (3) and washers (4).

(2) Using a suitable main bearing cap puller loosen each main bearing. Remove bearing caps (5, 6, 7, 8 and 9).

NOTE

Bearing shells and corresponding bearing caps must be kept together in sets.

(3) Remove lower bearing shells (10). Remove thrust rings (11) from each side of rear main bearing cap and roll upper half of thrust rings (11) from block.

(4) Connect rope or hooks protected by rubber hose to the crank ends. With a suitable hoist, lift crankshaft (12) from cylinder block.

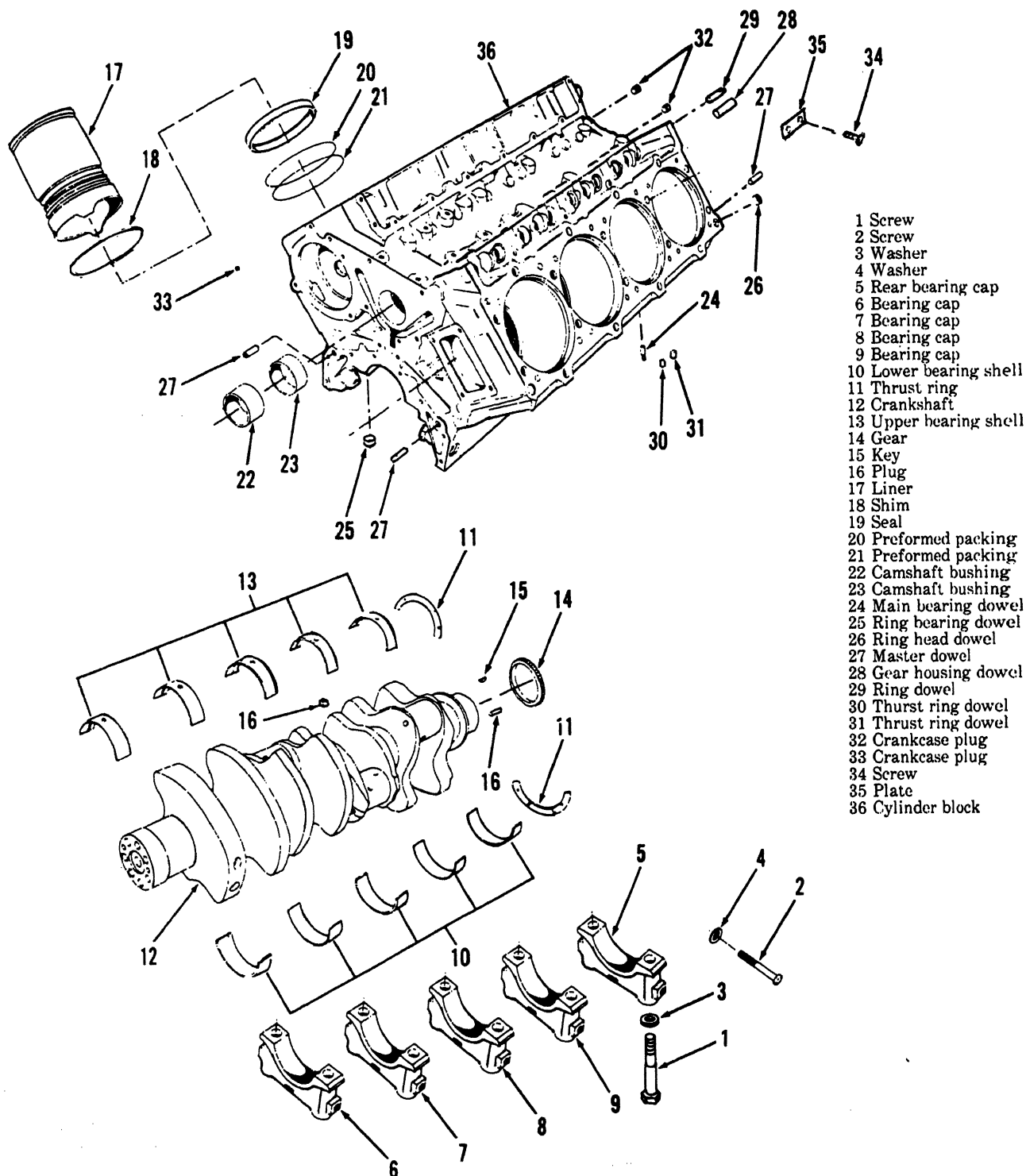
NOTE

Rotating crankshaft will assist in removal.

(5) Remove upper main bearing shells (13) from cylinder block. Place bearing shells together, marked with corresponding main bearing cap number.

(6) If crankshaft gear (14) is damaged remove with hammer and chisel. Strike chisel between teeth above the key-way several times to loosen gear enough to remove by hand. Remove gear key (15).

(7) Remove all pipe plugs (16).



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Figure 14-38. Crankshaft and cylinder block—exploded view.

b. Refer to figure 14-38. Disassemble cylinder block as follows:

(1) With a suitable liner puller and liner bridge or equivalent, remove liners (17), shims (18), seals (19) and preformed packing (20 and 21). Discard preformed packing and crevice seals.

CAUTION

Do not pull liners (17) with liner puller plate on or near extended portion of liner.

(2) Proceed to paragraph 14-36 and thoroughly inspect cylinder block. If after a complete inspection of block the existing block is to be reused, proceed to step (3).

(3) With a suitable camshaft bushing driver kit, or equivalent, remove bushings (22 and 23).

(4) If damaged, remove dowels (24, 25, 26, 27, 28, 29, 30 and 31).

(5) Remove crankcase plugs (32 and 33).

(6) If data plate is damaged, remove screws (34) and plate (35) from cylinder block (36).

14-36. Cleaning, Inspection

a. Clean all metal parts with cleaning solvent Federal Standard P-D-680, or equivalent. Thoroughly dry with compressed air.

b. Steam clean all disassembled parts (except those that might be damaged by steam or moisture) with a steam jet. Dry thoroughly with compressed air.

(1) Check liner protrusion above milled surface of block. An installed liner must protrude 0.003—0.0065 inch. To check protrusion without installing liner, perform the following:

(a) Using a micrometer, measure the liner flange. Do not include bead on top of liner flange. Measurement should be 0.355—0.356 inch.

(b) Check counterbore depth at four or more locations. Ledge must not be cupped more than 0.0007 inch. Depth must not vary more than 0.001 inch throughout counterbore circumference. If these requirements are not met, counterbore ledge must be reworked per paragraph 14-37.

(c) Calculate depth of cut that will permit using a standard size shim to provide the required liner protrusion. Normally a 0.007—0.009-inch cut will be adequate to recondition counterbore.

NOTE

If material to be removed will result in a counterbore depth exceeding 0.413 inch, block should not be reused.

(d) Check for variations in protrusion under each cylinder head. Variation shall not exceed 0.002 inch under head nor can it exceed 0.001 inch at any one liner.

(2) The most accurate method of checking liner protrusion is as follows:

(a) Install liner in block with proper number of shims beneath the flange. Shims are available from

0.007 to 0.062 inch. Cylinder liner must be held down evenly.

c. All old gasket material must be scraped from the block. Use care to avoid damaging seal surface.

d. Inspect the cylinder block on a flat surface to prevent distortion, do not leave on engine stand. The cylinder block shall be checked as follows:

(1) Inspect block for cracks, porosity, and leaks using the dye penetrant method.

(a) Clean suspected defective area with kerosene or other grease-removing cleaner.

(b) Apply dye penetrant and wait 15 minutes. Do not "force" dry.

(c) Remove all excess penetrant and apply developer so defects will stand out; cracks will show up as a solid or dotted line; caution must be observed as this can be a non-damaging forging lap. Porosity will be indicated by dots in local areas, the wider the area spreads, the larger the defect.

(2) Check block for corrosion. Corrosion normally occurs on portions of block nearest cylinder liners and is evidenced by pitting. If area cannot be cleaned, or is distorted and cannot be repaired, discard block.

(3) Check upper liner counterbore diameter, at four equidistant points (1, fig. 14-39). Inside diameter shall be no greater than 6.5015 inches. Depth (2) shall be less than 0.413 inch and shall not vary more than 0.001 inch at any one cylinder. Recondition as described in paragraph 14-37.

(a) Check liner protrusion above the cylinder block at four equidistant points outside the bead. Add or remove shims from beneath the liner flange as needed to reach 0.003—0.0065-inch protrusion.

(b) Check liner bore roundness at several points within range of piston travel. Liner shall not be out-of-round more than 0.002 inch in the packing ring area or more than 0.003 inch in the top one inch.

(4) Inspect camshaft bushing. Replace if chipped, scored or scratched. Check inside diameter with inside micrometer. Inside diameter shall be no greater than 2.502 inches. Check bore size if bushings have turned in block bore. Bore shall be 2.6865—2.6875 inches. Check to make sure all oil passages between bushings and block are properly aligned.

(5) Check cylinder liner bore as follows:

(a) Install a new cylinder liner in block without preformed packing or crevice seal.

(b) Clearance between liner and block should be 0.002—0.006 inch. Liner may contact block as long as contact does not cause liner to be out-of-round. Limits do not apply with cylinder head installed and tightened to operating torque. If clearance is not correct, check lower block packing ring bore inside diameter. Lower bore inside diameter shall be 6.107—6.109 inches.

(6) Inspect main bearing caps. Caps must fit in block with no perceptible clearance or "shake." Milled

faces of cap must always rest on mating portion of block to prevent distortion during tightening. Caps must have an interface fit to block of 0.000-0.0025 inch. Replace caps if these requirements cannot be met.

(7) Check main bearing bore as follows:

(a) Assemble main bearing caps to block in operating position. Tighten screws to 150—160 ft-lb (203.4—216.9 N·m), advance to 340—350 (461—475 N·m). Loosen to no tension, tighten 85—90 (115.2—122.0 N·m), and advance to 170—180 ft-lb (230.5—244.0 N·m).

(8) Inspect all block water passages to insure they are open. Check for eroded water holes which may prevent proper seating of head gasket or grommet retainers. Water holes not eroded more than one-sixteenth of an inch from edge of hole can be sleeved.

(9) Inspect tappet bores with an inside micrometer. If injector bore exceeds 1.4035 inches or valve bore exceeds 1.1035 inches or they are out-of-round more than 0.0015 inch, block must be replaced.

(10) Inspect cylinder liners for cracks under the top flange, at bottom of liner, or above seal ring groove. Discard any liner with excessive corrosion or erosion and one-sixteenth of an inch deep or more, or if dents or fretting of liner flange cannot be removed by lapping. Inside diameter of the liner shall not exceed 5.505 inches at 60°—70°F.

(11) Check block height from head surface to main bearing bore centerline. Distance must be greater than 13.143 inches.

NOTE

When measuring, block must be unsupported and on a flat surface.

(12) Distance from head surface to main bearing bore centerline must not vary more than 0.002 inch in each 20 inches of block length. Heat surface flatness must not vary over 0.0005 inch for each eight inches of surface on each bank. Waviness must not exceed 0.0004 inch in depth per square inch of area. If these requirements are not met, top surface shall be refinished.

NOTE

If an excess of 0.010 inch of material must be removed, block cannot be used.

e. Inspect crankshaft as follows:

(1) Inspect crankshaft gear for chipping, cracks, or broken teeth. If any damage is observed replace gear.

(2) Inspect crankshaft visually for scratches, nicks, cracks and obvious wear patterns.

(3) Measure crankshaft journals with a micrometer. Outside diameter of the connecting rod journal shall be no less than 3.122 inches. Outside diameter of main bearing journal shall be no less than 3.747 inches.

(4) Check crankshaft for out-of-round condition. Crankshaft shall be replaced if main bearing or crankpin journals are worn out-of-round more than 0.002 inch.

(5) Inspect crankshaft journals and thrust flange at rear main bearing. If surfaces are scored or scratched, crankshaft should be replaced.

14-37. Repair

Repair the cylinder block as necessary per the methods described immediately below if block is to be reused.

a. Replace camshaft bushing with a camshaft bushing driver kit or equivalent. Locate new bushings on drive mandrel, align oil holes in bushings and block, and install.

b. Replace main bearing caps as follows:

(1) Replacement main bearing caps have 0.003-inch material in bore and 0.0045-inch excess in length. New rear replacement cap does not have cap-to-block dowel holes and must be machined to block width.

(2) Machine an equal amount of material from each end of semi-finished cap to provide 0.001—0.003-inch interference fit in block.

(3) If cap is a rear cap, remove locating dowels from block. Locate and machine cap so thrust faces of cap and block are flush. Use Prussian Blue on block surface to locate dowel holes in cap. Install screws and torque to 55-lb-ft (74.6 N·m). Remove cap and drill dowel holes. Reinstall cap and ream dowel holes to smallest permissible oversize. Install dowel in block.

(4) If thrust bearing locating dowel must be replaced, install new dowel. Dowel must have 0.090—0.105-inch protrusion from machined area of bearing cap mating surface.

(5) Install all caps on block and ream bore to 4.062—4.063 inches.

c. Sleeve eroded water holes as described in the following steps.

(1) Water holes to be sleeved must be free of any erosion, scratches or blemishes which are more than 0.003 inch deep in the area $\frac{1}{16}$ to $\frac{1}{32}$ inch from their edges.

(2) Using a water hole counterboring tool or equivalent, enlarge holes for sleeve.

(3) Align sleeve in top of water passage hole, and with a suitable driver and hammer drive sleeve in until it bottoms. Sleeve will protrude above surface of block.

(4) If block is not to be resurfaced, file bushing flush with top of block, using a wide, flat file.

d. Refinish top-surface of block as follows:

(1) Place block on main bearing pads, remove ring dowels from head surface.

(2) With either a milling machine or large surface grinder, make light cuts of 0.001—0.003 inch deep, removing only enough material to make block usable.

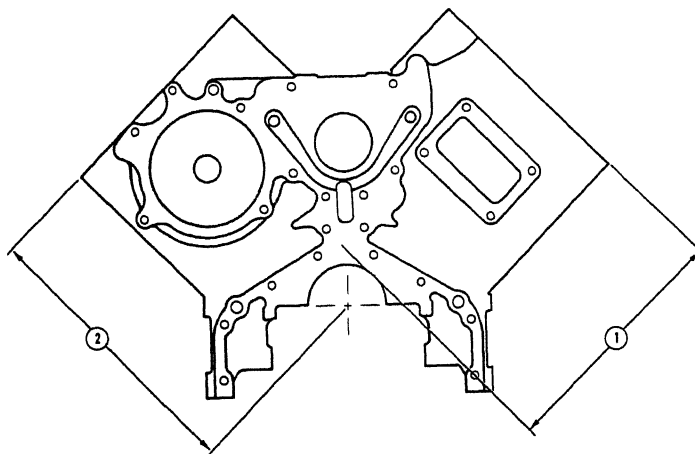
(3) Check distance from centerline of main bearing bore to top of block, (2, fig. 14-39). Distance shall be

greater than 13.142 inches.

NOTE

A 0.010-inch thicker head gasket, and grom-

rets are required when block has been resurfaced.



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Figure 14-39. Cylinder block height.

(4) Finish surface to 125 R.M.S.

(5) Resurface counterbore to obtain proper liner protrusion. Check liner to block contact in crevice seal area.

e. Resurface cylinder liner counterbore if block has been resurfaced, ledge is uneven, or where liner protrusion is incorrect.

f. Replace cylinder liner if required. All new cylinder liners shall be "prebrushed" and cleaned before assembly to assure no abrasives are present in the lubrite coating.

14-38. Assembly and Installation

a. Refer to figure 14-38. Using a suitable lifting device, lift cylinder block (36) to an engine stand. Fasten securely. Assemble plate (35) and screw (34).

b. Check all oil passages in block to be sure they are clear and open. Install pipe plugs (33 and 32) torque as follows:

- (1) $\frac{1}{8}$ -inch plug 5—15 ft-lb (6.8—20.3 N · m)
- (2) $\frac{3}{8}$ -inch plug 30—45 ft-lb (40.7—61.0 N · m).
- (3) $\frac{1}{2}$ -inch plug 45—55 ft-lb (61.0—74.6 N · m).

NOTE

Use sealing tape or equivalent on all pipe plugs to insure an effective seal.

c. Assemble and install crankshaft as follows:

(1) Recheck all oil passages of crankshaft to be sure they are open and clean. Install pipe plugs (16) in crankshaft oil passages and stake securely.

(2) Install crankshaft gear (14) if removed as follows:

(a) Install key (15).

(b) Heat gear in an oven at 400°F. for one hour.

(c) Lubricate flange with high pressure grease and drive gear (14) onto shaft.

(3) Turn cylinder block upside down. Lay clean upper main bearing shells (13) in block engaging tang in recess. Coat upper main bearing shells thoroughly with clean engine oil.

NOTE

All tangs must be in recesses before main bearing caps are torqued.

(4) Using a suitable hoist, lift crankshaft (12) into position, using hooks protected with rubber hose or a suitable sling around two crank throws.

(5) Apply clean engine lubricating oil to crankshaft side of thrust ring (11) and roll upper half-rings into position, grooved sides next to crankshaft flange.

(6) Position lower main bearing shells (10) into the corresponding main bearing cap (6, 7, 8 and 9).

NOTE

Lower main bearing shells are plain with no grooves and no drillings.

(7) Coat lower main bearing shells (10), on crankshaft surface, with clean engine lubricating oil.

(8) Install lower thrust half-rings to rear cap (5), locate dowels to rear main bearing cap.

NOTE

If a two-dowel pin rear main bearing cap is serviced with a thrust half-ring containing a single dowel hole, remove the one-fourth inch dowel from cap and discard. A two-dowel hole thrust half-ring may be used with a single-dowel main bearing cap.

(9) Install main bearing caps so numbers stamped on cap correspond with numbers on block. Locking tangs of cap and block must be on same side of block.

NOTE

Main bearing caps are not interchangeable.

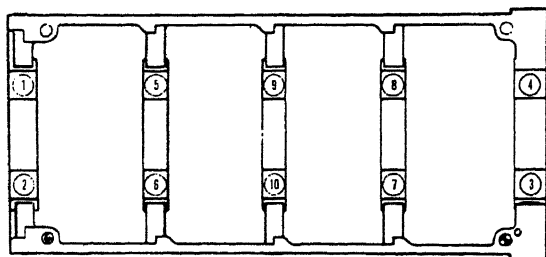
(10) Coat threads of screws (1) with clean engine oil. Lubricate washers (3) and shoulders of screw heads (1) with 140-wt. lubricant. Threads must be completely covered with an oil film and must not be damaged. Install washers (3) and start each screw (1). Set bearing caps in position by alternately tightening screws.

CAUTION

Driving main bearing caps into position may dislodge lower bearing half.

(11) Lubricate washers (4) and threads and shoulders of screws (2) with clean engine oil. Install washers (4) and start main bearing cap side screws (2). Screws will be torqued after the crankshaft end clearance check.

(12) Tighten main bearing screws by method outlined below. Torquing sequence is as shown in figure 14-40.



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Figure 14-40. Main bearing torquing sequence.

(a) Tighten all screws on each cap in 50—60 ft-lb (67.8—81.3 N·m) increments to 150—160 ft-lb (203.4—216.9 N·m).

(b) Tighten all screws in 100 ft-lb (135.6 N·m) increments to 340—350 ft-lb (461—475 N·m).

(c) Loosen all screws to relieve all tension.

(d) Tighten all screws in 45—50 ft-lb (61.0—67.8 N·m) increments to 85—90 ft-lb (115.2—122.0 N·m).

(e) Tighten all screws in 50 ft-lb (67.8 N·m) increments to 170—180 ft-lb (230.5—244.0 N·m).

(f) Advance all screws 60° in 30° increments.

(13) Check crankshaft end clearance as outlined in the following steps.

(a) Attach dial indicator gauge to cylinder block with contact point of gauge resting on crankshaft flange face.

(b) Using a small pry bar, pry crankshaft completely forward (toward front of the engine). Remove pry bar and set indicator to "0."

(c) Pry crankshaft toward rear of engine and again remove pry bar. Total end clearance shall be 0.004—0.016 inch with new thrust rings.

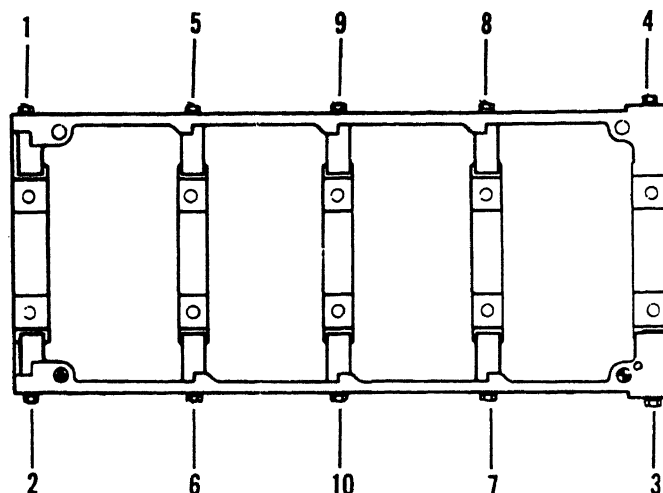
(d) Rotate crankshaft to see that it rotates freely.

(e) If end clearance is less than 0.005 inch, loosen screws slightly and shift crankshaft toward front end of engine then toward rear of engine. Retighten screws as described in paragraph 14-38c(12). Recheck end clearance.

(f) With used thrust rings, end clearance shall not exceed 0.022 inch. If end clearance exceeds 0.022 inch, new or oversized thrust rings must be installed.

(14) Check clearance between main bearing cap at side screw and cylinder block area on each side. There shall be 0.0015—0.0035-inch clearance before side screws are installed.

(15) Torque screws (2) using sequence in figure 14-41, as follows:



TA033297

Figure 14-41. Side screw torquing sequence.

(a) Tighten to 25 ft-lb (33.9 N · m).

(b) Tighten to 70—75 ft-lb (94.9—101.7 N · m).

(c) Tighten to 140—150 ft-lb (189.8—203.4 N · m).

d. Check and replace dowels (24, 25, 26, 27, 28 and 29) if damaged.

e. Install cylinder liners (17) to block as described in following:

CAUTION

Before installing cylinder liners, check for and remove nicks or burrs in the liners lower skirt end, extended portion protruding in bore that could cause scoring of pistons. Remove all sharp edges or nicks in block lower bore which could distort liner sealing.

(1) Check and establish liner protrusion as described in paragraph 14-36b(1)(d). If required, install shims (18) around liners to maintain liner protrusion of 0.003—0.0065 inch.

(2) Coat preformed packing (20 and 21) and packing lands on liner with light coat of clean engine oil.

(3) Install crevice seal (19) on flat machine surface above packings with beveled side out on bottom of liner.

(4) Roll each liner packing (18) into position. Care must be taken not to stretch packing out of shape. Check for twisted packing in grooves, using mold mark on packing as guide; straighten as required.

(5) Lubricate machined preformed packing bore of block with light coat of clean engine oil. Push liner (17) into place by hand carefully, avoid dislodging crevice seal.

CAUTION

Alignment marks on cylinder block and liners must be in alignment within five-eighths of an inch from end to end of block after installation to prevent crankshaft throw contact with liner tabs.

(6) With a suitable liner driver and soft hammer, drive liner into block counterbore. Tap lightly as liner is seated to prevent "bounce."

(7) With suitable liner hold down clamps placed at equidistant points; torqued to 75 ft-lb (101.7 N · m), check liner to block protrusion. Protrusion must be a uniform 0.003—0.0065 inch. Remove clamps.

(8) Check liner bore for roundness at several points within range of piston travel. If liner is more than 0.002 inch out-of-round in packing ring area, or 0.003 inch in top one inch, remove liner and check for possible twisted preformed packing, cocked liner seal, or liner to block contact which could cause liner bore distortion.

NOTE

Most accurate measurements can be made with block removed from engine stand.

CHAPTER 15

REPAIR OF CARRIER DRIVE TRAIN

Section I. TRANSMISSION

15-1. General

The transmission portion of the drive train plays an important role in delivering engine power to the driving wheels. The transmission and torque converter function together and operate through a common hydraulic system, although they are separate units.

15-2. Removal

Refer to paragraph 12-7 and remove the transmission

from the carrier.

15-3. Disassembly

a. Refer to figure 15-1. Remove drain plug (1) and drain transmission. Remove sump pan screws and washers (2) and separate sump pan (3) from the transmission housing. Remove magnet (4) and gasket (5).

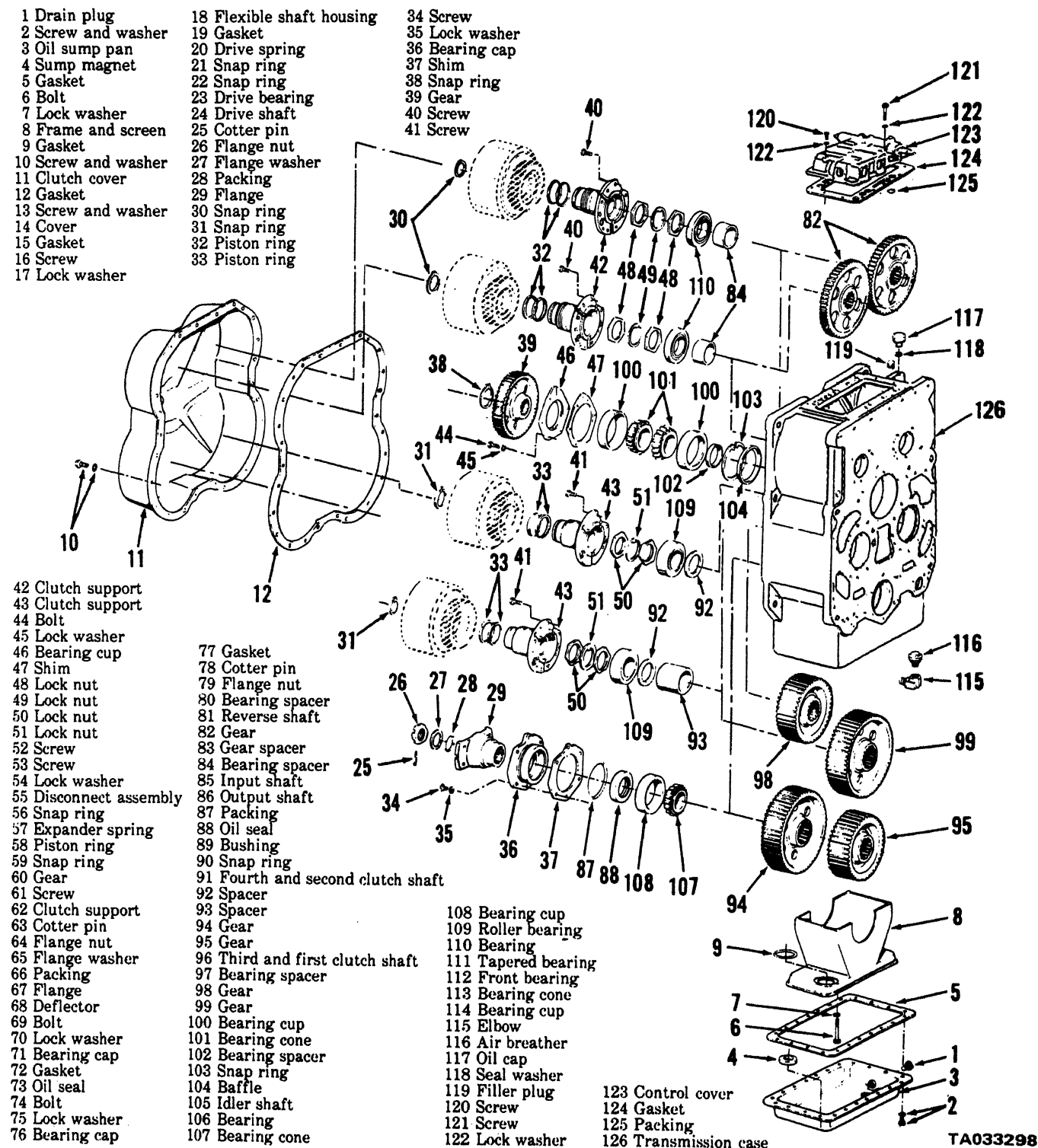
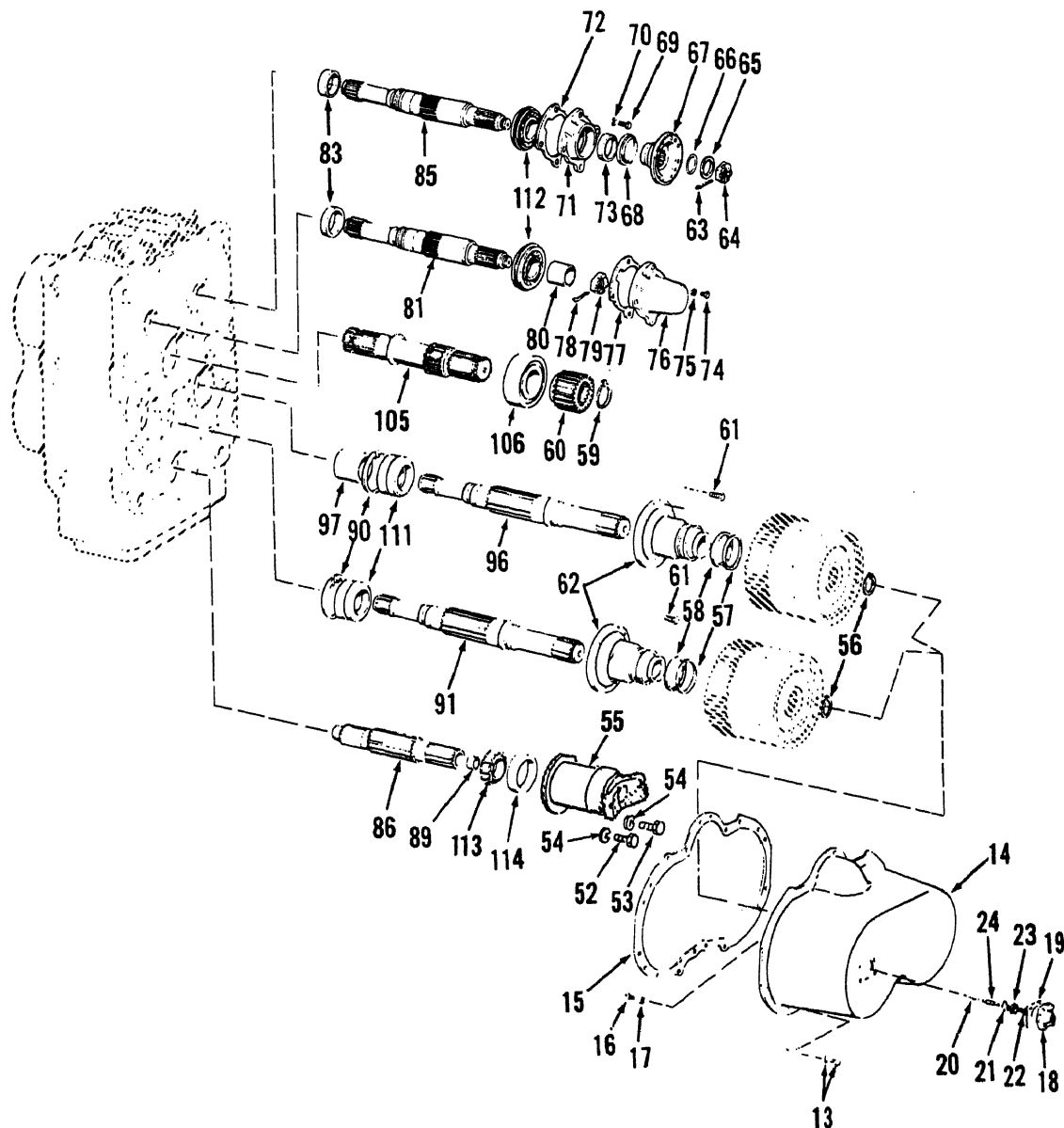


Figure 15-1. Transmission assembly—exploded view (sheet 1 of 2).



TA033299

Figure 15-1. Transmission assembly—exploded view (sheet 2 of 2).

b. Remove screen bolts (6) and lock washers (7). Remove screen (8) and gasket (9).

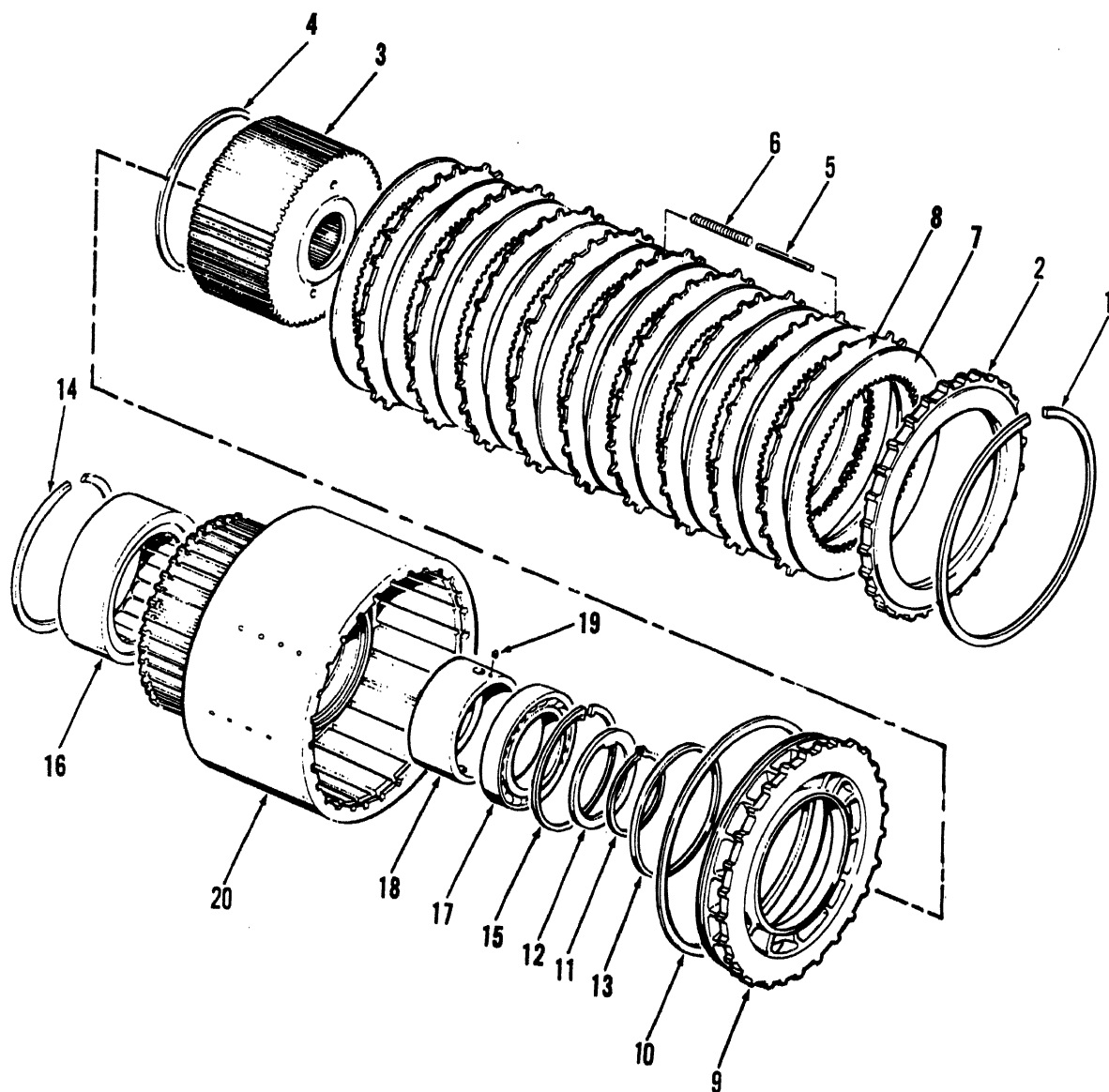
c. Remove clutch cover screw and washer sets (10) and remove clutch cover (11) and gasket (12). Remove screw and lock washer sets (13), cover (14) and gasket (15).

d. Remove screws (16), lock washers (17), flexible shaft housing (18) and gasket (19). Remove drive spring (20), snap rings (21) and (22), drive bearing (23) and drive shaft (24).

e. Lock transmission gears with a soft bar and remove cotter pin (25), flange nut (26), flange washer (27), packing (28) and flange (29).

f. The input, reverse, third and fourth clutch assemblies are disassembled in a similar manner as follows: Remove snap rings (30) and (31).

(1) Refer to figure 15-2, which shows the disassembly procedure for the input, reverse, third and fourth clutch assemblies.



TA033374

- 1 Snap ring
- 2 End plate
- 3 Disc hub
- 4 Baffle ring
- 5 Spring pin
- 6 Spring
- 7 Inner disc
- 8 Outer disc
- 9 Piston
- 10 Outer ring

- 11 Snap ring
- 12 Washer
- 13 Inner ring
- 14 Snap ring
- 15 Snap ring
- 16 Support bearing
- 17 Ball bearing
- 18 Outer race
- 19 Lock ball
- 20 Drum

15-2. Input, reverse, third and fourth clutch assemblies—exploded view.

- 1). (4) Remove clutch piston (9) and outer ring (10). Remove snap ring (11) and retainer washer (12). Remove clutch drum and bearing assembly.
- (5) Remove inner ring (13). Remove snap rings (14) and (15). Press bearings (16) and (17) from drum

(20).

(6) Press piston ring outer race (18), from drum (20) being careful not to lose lock ball (19).

g. Refer to figure 15-1 and remove piston rings (32) and (33).

h. Remove bearing cap screws (34) and lock washers (35). Remove bearing cap (36) and shims (37).

i. Remove idler gear retaining ring (38) and idler gear (39). Remove clutch support screws (40) and (41), and clutch supports (42) and (43).

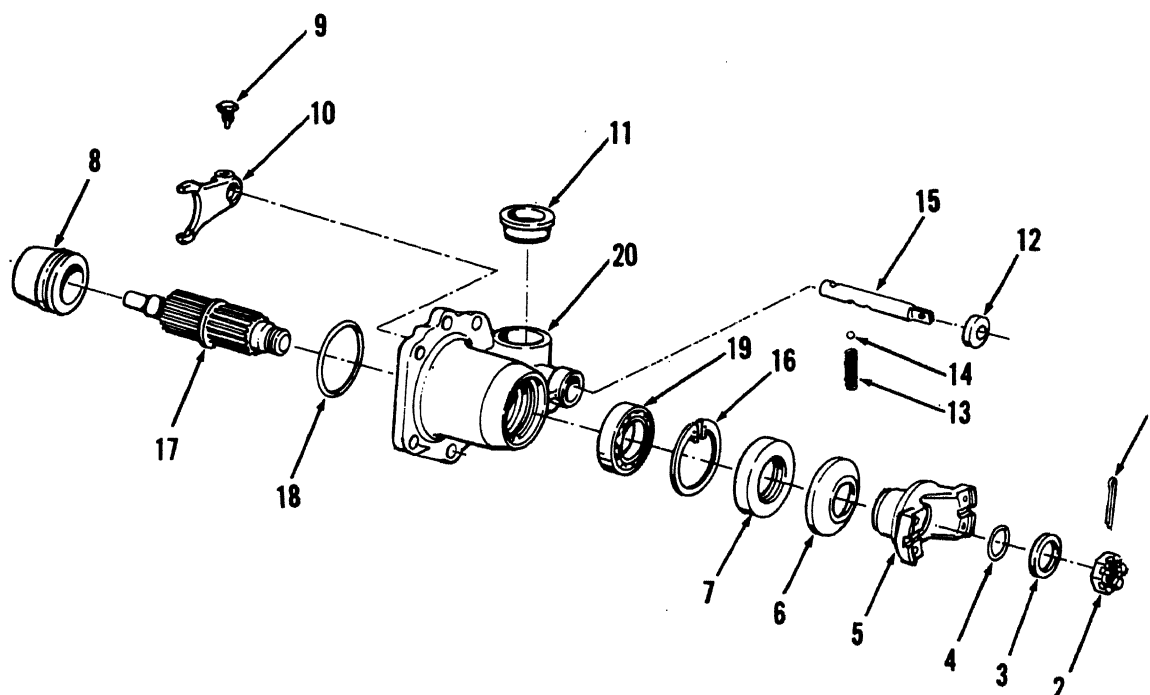
j. Remove idler shaft bearing cap bolts (44) and lock

washers (45). Remove bearing cap (46) and shims (47).

k. Straighten tangs on bearing nuts (49) and (51). Lock transmission gears with a soft bar and remove lock nuts (48), (49), (50) and (51).

l. Remove disconnect mounting screws (52) and (53) and lock washers (54). Remove disconnect assembly (55) and disassemble as follows:

(1) Refer to figure 15-3. Remove cotter pin (1), flange nut (2), flange washer (3) and packing (4). Remove flange (5), deflector (6) and oil seal (7).



TA033300

1 Cotter pin
2 Flange nut
3 Flange washer
4 Packing
5 Flange
6 Deflector
7 Oil seal
8 Hub
9 Set screw
10 Shift fork

11 Pipe plug
12 Oil seal
13 Detent spring
14 Detent ball
15 Shift rail
16 Snap ring
17 Shaft
18 Packing
19 Bearing
20 Housing

Figure 15-3. Disconnect assembly—exploded view.

(2) Remove hub (8), set screw (9) and shift fork (10). Remove plug (11).

(3) Remove oil seal (12), detent spring (13) and detent ball (14) from shift rail (15).

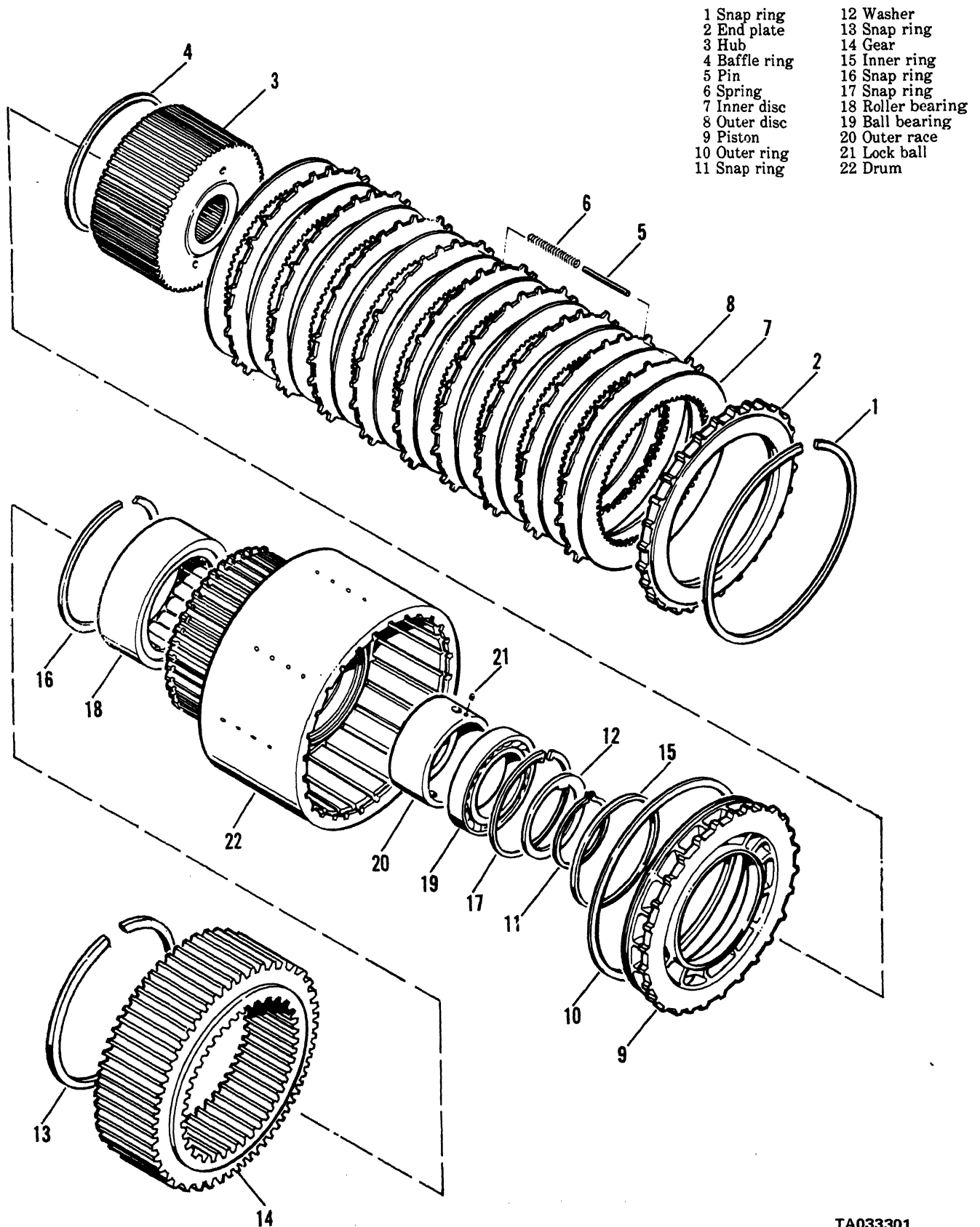
(4) Remove snap ring (16) and slide shaft (17) from the assembly.

(5) Remove packing (18) from housing (20). Press

bearing (19) from the housing.

m. Remove snap rings (56, fig. 15-1) to disassemble the first and second clutch assemblies as follows:

(1) Refer to figure 15-4 which shows the disassembly procedure for the first and second clutch assemblies.



TA033301

Figure 15-4. First and second clutch assemblies —exploded view.

(2) Depress end plate and remove snap ring (1). Remove end plate (2).

(3) Remove clutch disc hub (3) and baffle ring (4). Remove spring pin (5) and spring (6). Remove inner disc (7) and outer discs (8).

(4) Remove clutch piston (9) and outer ring (10). Remove snap ring (11) and retainer washer (12). Remove clutch drum and bearing assembly.

(5) Remove snap ring (13) and drum hub gear (14).

(6) Remove inner ring (15) and snap rings (16) and (17). Press bearings (18) and (19) from drum (22).

(7) Press piston ring outer race (20) from drum (22), being careful not to lose lock ball (21).

n. Refer to figure 15-1 and remove expander rings (57) and piston rings (58) from their respective shafts. Remove idler gear snap ring (59) and idler gear (60).

o. Remove clutch support screws (61) and clutch supports (62).

p. Remove cotter pin (63), flange nut (64), flange washer (65), packing (66), flange (67) and deflector (68). Remove bolts (69), lock washers (70), bearing cap (71) gasket (72) and oil seal (73).

q. Remove bolts (74), lock washers (75), bearing cap (76), and gasket (77). Remove cotter pin (78), flange nut (79) and bearing spacer (80).

r. Using a suitable pusher tool, remove shaft (81), pushing from the lock nut side. Remove gear (82), and spacers (83) and (84) from the housing.

s. Using a suitable pusher tool, push input shaft (85), pushing from the lock nut side. Remove gear (82) and spacers (83) and (84) from the housing.

t. Using a suitable tool, press output shaft (86) from the housing. Remove packing (87) and oil seal (88). Remove bushing (89) from the shaft.

u. Remove snap rings (90) from the remaining shafts. Using a suitable pusher tool, remove fourth and second clutch shaft (91) from the housing, pushing from the lock nut side. Remove spacers (92) and (93) and gears (94) and (95) from the housing. Remove third and first clutch shaft (96), pushing from the lock nut side. Remove spacers (92) and (97), and gears (98) and (99).

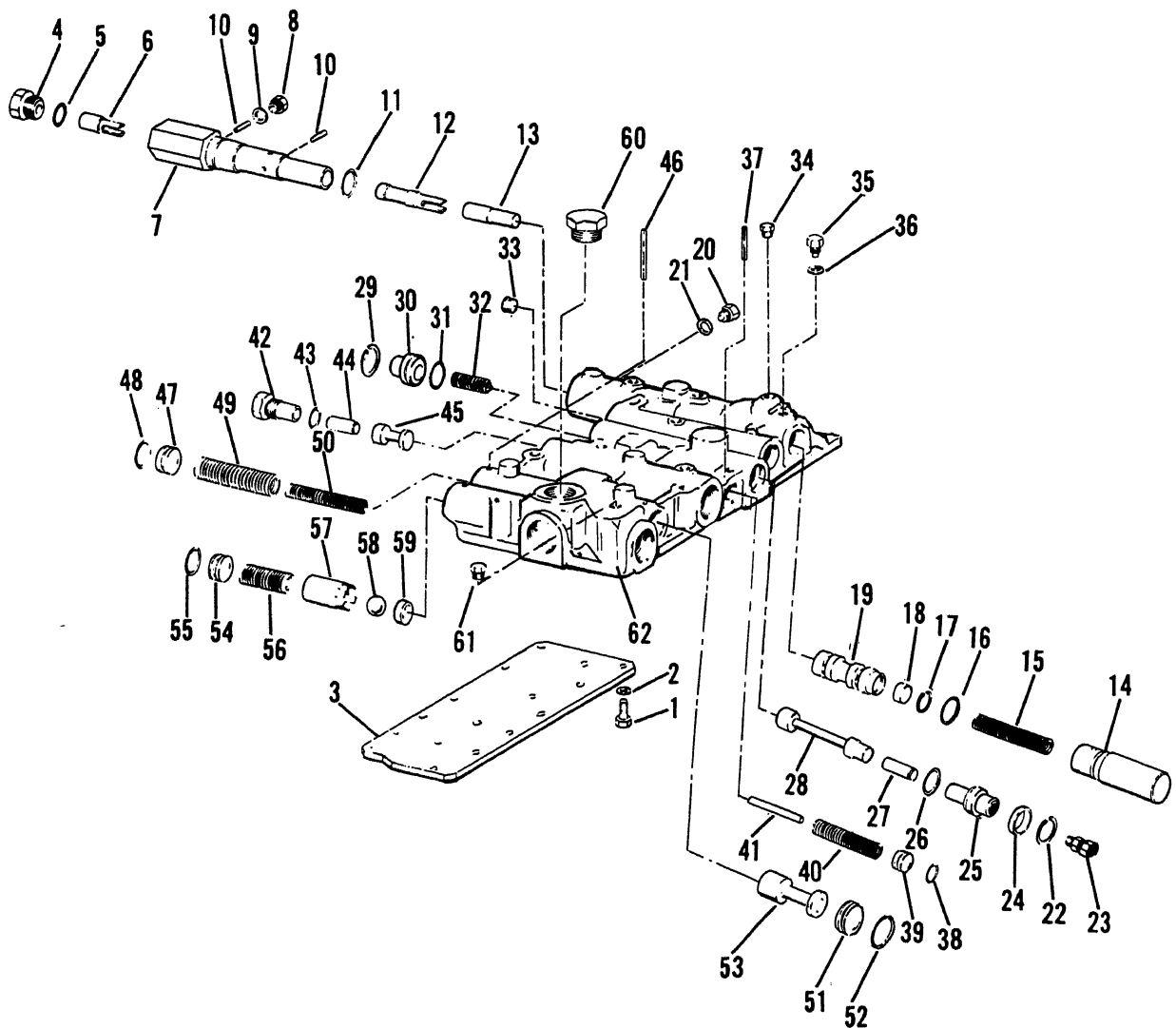
v. Push idler shaft (105) out of housing until double cone bearing cups (100) and bearing cones (101) are exposed on the opposite side. Remove bearing spacer (102), snap ring (103) and baffle (104). Pull bearings (101) and cups (100) from the shaft. Push idler shaft (105) from the housing from the double bearing side. Remove bearing (106) from the shaft.

w. Press bearing cone (107) and cup (108) from the housing. Press roller bearings (109) and (110) from the housing. Press bearings (111) and (112) from the housing. Remove cone bearing (113) and press bearing cup (114) from the housing.

x. Remove elbow (115) and air breather (116) from housing (126). Remove oil cap (117), seal washer (118) and filler plug (119).

y. Remove control cover from the housing by removing screws (120) and (121), lock washers (122), control cover (123), gasket (124) and packing (125). Disassembly of the control cover is as follows:

(1) Refer to figure 15-5, which shows the disassembly procedure of the transmission control cover.



TA033302

- | | | | |
|---------------------|---------------------|---------------------|-----------------|
| 1 Screw | 17 Snap ring | 32 Spring | 47 Stop |
| 2 Lock washer | 18 Plug | 33 Pipe plug | 48 Packing |
| 3 Oil circuit plate | 19 Selector valve | 34 Pipe plug | 49 Spring |
| 4 Shift plug | 20 Plug | 35 Plug | 50 Spool spring |
| 5 Packing | 21 Washer (special) | 36 Washer (special) | 51 Stop |
| 6 Valve | 22 Snap ring | 37 Roll pin stop | 52 Packing |
| 7 Valve housing | 23 Adapter | 38 Packing | 53 Spool |
| 8 Plug | 24 Spacer | 39 Valve stop | 54 Stop |
| 9 Washer (special) | 25 Piston guide | 40 Spring | 55 Packing |
| 10 Valve pin stop | 26 Packing | 41 Pin | 56 Spring |
| 11 Packing | 27 Piston | 42 Guide | 57 Spacer |
| 12 Valve | 28 Valve | 43 Packing | 58 Ball |
| 13 Valve | 29 Cap washer | 44 Piston | 59 Seat |
| 14 End plug | 30 Spring cap | 45 Spool | 60 Plug |
| 15 Spring | 31 Packing | 46 Roll pin | 61 Pipe plug |
| 16 Packing | | | 62 Cover |

Figure 15-5. Control valve assembly—exploded view.

by removing screws (1) oil circuit plate (3).
packing (5) and valve
ightly, and remove valve

housing (7). Remove plug (8) from the valve housing
special washers (9) and valve pin stops (10).

(4) Remove packing (11) and valves (12) and (13).
Remove end plug (14), spring (15), and packing (16).

Remove snap ring (17), plug (18) and selector valve (19). Remove plug (20) and special washer (21).

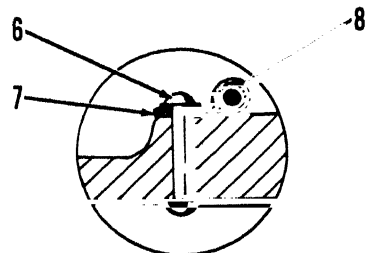
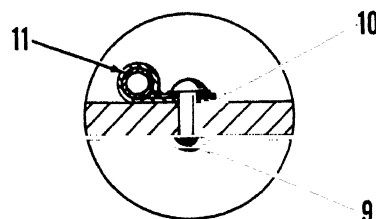
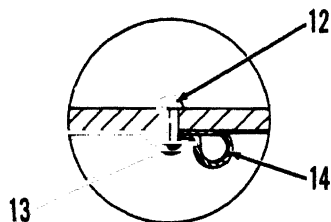
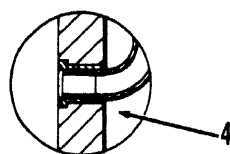
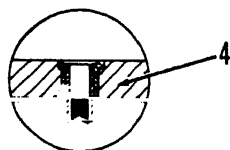
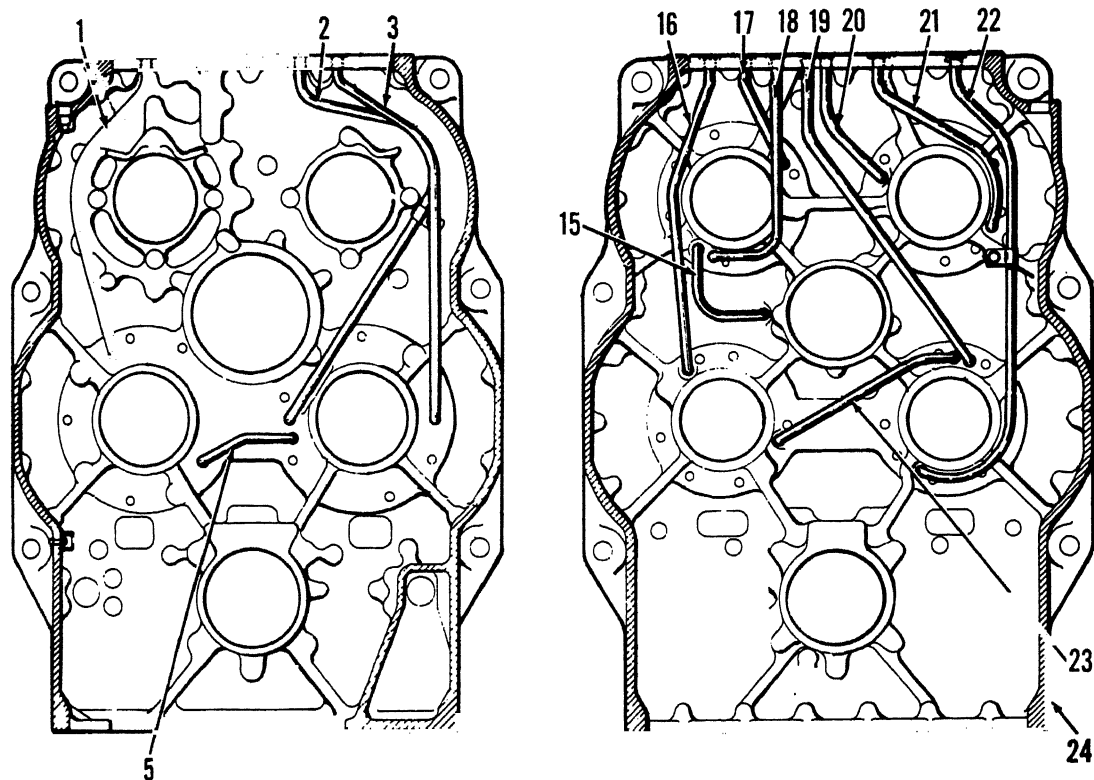
(5) Remove snap ring (22) and gently tap the opposite end of the cover to remove assembly. Remove adapter (23), spacer (24), piston guide (25), packing (26), piston (27) and valve (28). At the opposite end of the cover, remove cap washer (29), spring cap (30), packing (31) and spring (32). Remove pipe plug (33).

(6) Remove plug (34), plug (35) and special washer (36). Using a suitable press to compress stop (39), remove roll pin stop (37). Then remove stop (39) and packing (38), spring (40), and pin (41). At the opposite end of the cover, remove guide (42), packing (43), piston (44) and spool (45).

(7) Using a suitable press, depress stop (47) and remove pin (46). Gently tap the opposite end of the cover and remove stop (47), packing (48), spring (49) and spool spring (50). From the opposite end of the cover, remove stop (51), packing (52) and spool (53).

(8) Depress stop (54) and remove remaining pin (46). Remove stop (54), packing (55), spring (56), spacer (57), ball (58) and seat (59). Remove plug (60) and pipe plug (61) from cover (62).

z. The transmission internal tubing is shown in figure 15-6. These tubes should not be removed unless damaged. They should, however, be cleaned and checked when the transmission is disassembled.



TA033:

- 1 Tube
- 2 Tube
- 3 Tube
- 4 Sleeve
- 5 Cross tube
- 6 Solid rivet
- 7 Washer
- 8 Clip

- 9 Solid rivet
- 10 Washer
- 11 Clip
- 12 Solid rivet
- 13 Washer
- 14 Clip
- 15 Cross over tube
- 16 Tube

- 17 Tube
- 18 Tube
- 19 Tube
- 20 Input tube
- 21 Tube
- 22 Tube
- 23 Tube
- 24 Transmission cas

Figure 15-6. Transmission internal tubing.

15-4. Cleaning, Inspection and Repair

a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent before inspecting. Immerse parts in cleaning solvent and slush up and down slowly until all previous lubricant and foreign material is dissolved and parts are thoroughly cleaned.

b. Remove bearing from cleaning solvent and strike larger side of cone flat against a block of wood to dislodge solidified particles of lubricant. Immerse again in solvent to flush out particles. Repeat this procedure until bearings are clean.

c. Dry bearings with dry compressed air, being careful not to cause bearings to spin.

d. Clean interior and exterior of housing, sumps and covers, bearing caps, etc., thoroughly. All parts must be thoroughly dried immediately using dry compressed air or soft, lintless wiping rags.

e. Replace all seals, packings, and gaskets.

f. Carefully inspect all rollers, cages and cups for wear, chipping or nicks. Do not replace a cone or cup individually without replacing the mating cup or cone. After inspection, dip bearings in transmission fluid and wrap in clean lintless cloth or paper until installation.

g. If available, inspect gears and shafts using the magnetic flux process. Examine teeth on all gears for wear, chipping, pitting, nicks and burrs, cracks and scoring. If gear teeth show evidence of wearing through case hardened finish, replace the gear. Small nicks may be removed with a suitable hone.

h. Inspect shafts to assure that they are not sprung or bent, have no twisted splines and that shafts are true. Replace any shaft showing evidence of the above.

i. Inspect housing, covers and bearing caps to assure that they are thoroughly cleaned and that mating surfaces, bearing bores, etc., are free of nicks and burrs. Check all parts carefully for evidence of cracks, fatigue, or other conditions that would cause subsequent oil leaks or failures.

15-5. Reassembly

a. Refer to figure 15-1. Note that the drive shafts must be installed in the following order: idler shaft, first and third shaft, second and fourth shaft, output shaft, reverse shaft, and the input shaft.

b. Install ring (103) and baffle (104) in idler bearing bore. This must be done from the inside of the housing. The flanged oil baffle (104) must be one-eighth of an inch from the bearing locating ring (103).

c. Install inner bearing cup (100) in the idler bearing bore. Press roller bearing (106) onto idler shaft (105). Install the bearing and shaft into the housing from the side indicated (opposite side of inner bearing cone). Install spacer (102) on the shaft from the tapered bearing side of the shaft.

NOTE

This spacer has a taper on the outer edge.

Taper must face toward the tapered bearing.

d. Install inner tapered bearing (101) on the shaft with large diameter of taper outward. Install outer tapered bearing (101) on the shaft with large diameter taper inward. Install outer tapered bearing cup (100) on the idler shaft, driving the outer tapered cup against the outer tapered bearing.

e. Install idler bearing cap shims (47) and bearing cap (46). Install bolts (44) and lock washers (45). Tighten bolts (44) to 47—65 ft-lb (63.7—88.1 N·m). Adjust idler shaft taper bearing by adding or omitting shims (47) to 0.0 to 0.003-inch end play.

f. Install ring (90) in the first and third shaft bearing bore. Press double taper bearing (111) onto shaft (96).

CAUTION

Bearings (111) are in matched sets. Under no circumstances may any of the four parts be mixed with or exchanged with parts from another set.

g. Position gear (98) in the transmission case. Install spacer (97) on the shaft against the taper bearing assembly. Insert the assembled shaft into bore of case through gear (98), from the side indicated. Using a suitable pusher tool, push the shaft assembly into the case until the taper bearing shoulders against the locating ring in the bore of the case. Do not remove the pusher tool at this time.

h. Install spacer (92) against gear (98). Install roller bearing (109) on the shaft and drive the bearing into place. Drive the bearing in until spacer (97) cannot be turned by hand. Do not attempt to draw the bearing tight with bearing lock nut. Remove shaft pusher tool.

i. Install ring (90) into second and fourth shaft bearing bore. Press double taper bearing (111) onto shaft (91). Do not mix or substitute bearing parts with another set. These parts are matched. Position gear (99) in transmission case with long offset of gear hub toward the input side of the case. Insert shaft (91) into bore and through gear (99). Push shaft assembly into the case until bearing (111) shoulders against the locating ring. Do not remove the pushing tool at this time.

j. On opposite end of the shaft, install long gear spacer (93) on the shaft against gear (99). Install spacer (92) against the long spacer (93). Install roller bearing (109) on the shaft and drive into place until spacer (93) cannot be turned by hand. Do not attempt to draw bearing tight with bearing lock nuts. Remove shaft pusher tool.

k. Install first and second clutch supports (62) and secure with screws (61). Tighten bolts to 70—85 ft-lb (94.9—115.2 N·m). Install expander springs (57) and piston rings (58).

l. Install taper bearing (113) on output shaft (86). Position gears (94) and (95) in transmission case so that the gears are properly stacked. Insert shaft (86) through the bearing bore and gears (94) and (95). Block the shaft and install bearing (107) with large diameter inward, until bearing shoulders against the gear. Install bearing cups (114) and (108) over the bearing cones.

m. Refer to figure 15-3 and assemble the disconnect as follows:

(1) Install bearing (19) in bore of housing (20). Install shift fork (10) and bushing (8) on shaft (17). Insert the assembled shaft into housing (20) and through bearing (19). Secure the shaft with snap ring (16).

(2) Install detent ball (14) and detent spring (13) into position in the housing, and insert shift rail (15) into position. Secure the shift rail in position with set screw (9). Install oil seal (12).

(3) Install oil seal (7) and deflector (6) on the shaft. Install flange (5), packing (4), flange washer (3) and flange nut (2). Secure with cotter pin (1). Install packing (18) on the housing.

n. Refer to figure 15-1. Install disconnect assembly (55) on the transmission case and secure with screws (52) and (53) and lock washers (54). Tighten screws to 47—55 ft-lb (63.7—74.6 N · m). Temporarily install flange nut (26) on the output shaft. Using an inch-lb. torque wrench, turn the output shaft and gear train. Record the information and remove the flange nut.

o. Install oil seal (88) and packing (87). Install shims (37) and bearing cap (36). Secure with screws (34) and lock washers (35). Tighten screws (34) to 47—55 ft-lb (63.7—74.6 N · m). Install flange (29), packing (28), flange washer (27) and flange nut (26). Using the inch-pound torque wrench, turn the output shaft and gear train. When bearings are properly preloaded, it will require 6 to 8 inch-pounds more to turn the gear train and shaft than it did in the previous step. Add or remove shims until proper preload is attained. Install cotter pin (25).

p. Press bearing (112) onto shaft (85) as indicated. Install short spacer (83) on the shaft. Position input gear (82) in the case with longer offset of the gear to the rear. Install input shaft, spacer and bearing assembly into the case bore and through the input gear.

bearing cap (71) on the transmission case. Install bearing cap bolts (69) and washers (70). Tighten bolts to 47—55 ft-lb (63.7—74.6 N · m). Install oil deflector (68), companion flange (67), packing (66) flange washer (65) and flange nut (64). Tighten nut to 150—175 ft-lb (203.4—237.3 N · m). Secure with cotter pin (63).

r. Press bearing (112) onto reverse shaft (81) as indicated. Install short spacer (83) on the shaft. Position reverse gear (82) in the case with longer offset of the gear to the rear. Install reverse shaft, spacer and bearing assembly into the case bore and through the reverse gear. Using a suitable shaft pusher tool, push the reverse shaft into the bore until the bearing seats against the bearing bore. Do not remove the pusher tool at this time. Install large spacer (84) on shaft (81) against the reverse gear. Drive bearing (110) into place until spacer (84) cannot be turned by hand. Do not attempt to draw the bearing into position with the bearing lock nuts. Remove shaft pusher tool.

s. Install gear spacer (80) and nut (79) on shaft (81). Tighten nut (79) to 150—175 ft-lb (203.4—237.4 N · m). Install cotter pin (78). Install new gasket (77) and bearing cap (76). Install bearing cap bolts (74) and lock washers (75).

t. Lock gears using a soft bar. Install bearing inner lock nuts (48) and (50) on all four shafts. Tighten lock nuts to 175—200 ft-lb (237.4—271.2 N · m). Install center lock nuts (49) and (51), and outer lock nuts (48) and (50). Tighten outer lock nuts to 175—200 ft-lb (237.4—271.2 N · m). Bend tangs on center lock nuts alternately over flats on the inner and outer lock nuts.

u. Install clutch supports (42) and (43) and secure with screws (40) and (41). Tighten screws to 70—85 ft-lb (94.9—115.2 N · m). Install new piston rings (32) and (33). Lubricate piston rings with automatic transmission fluid. Install large idler gear (39) with longer offset of gear hub inward. Install idler gear retainer ring (38).

v. Refer to figure 15-3 and tighten flange nut (2) to 250—300 ft-lb (338.9—406.7 N · m).

w. Refer to figure 15-1. Install small idler gear (60) and secure with snap ring (59).

x. Refer to figure 15-4 for assembly procedures for the first and second clutch assemblies.

(1) Insert lock ball (21) into outer race (20). Press outer race and ball assembly into clutch drum (22). Outer race must be pressed from flush to one-sixty-fourth of an inch below shoulder in the clutch drum.

(2) Press support ball bearing (19) into clutch drum and secure with snap ring (17). From the rear end of the clutch drum, press support roller bearing (18) in drum (22). Secure with snap ring (16).

(3) Press clutch drum hub gear (14) on clutch drum with longer offset of gear hub inward. Secure with snap ring (13).

(4) Install clutch drum assembly on clutch support

(figure 15-1). Be careful not to damage clutch support piston rings.

(5) Install bearing washer (12) and snap ring (17). Install clutch piston inner ring (15) inside drum. Lubricate ring with transmission fluid. Install outer ring (10) in piston (9).

(6) Slide clutch piston (9) into position in the drum. Install baffle ring (4) on hub (3), and install the hub in the clutch drum.

(7) Install disc hub retainer ring (fig. 15-1, item 56).

(8) Install one inner disc spline teeth on inner diameter, on disc hub and against clutch piston (9).

(9) Install one outer clutch disc (8), spline teeth on outer diameter, in clutch drum.

NOTE

The outer disc has teeth missing on the outer diameter to allow passage for the clutch release springs. Insert two or more release springs (6) in drum and against the teeth of the clutch piston. Install next inner disc. Alternate clutch discs, outer against inner, and always align the teeth on each outer disc with the teeth on the preceding outer disc. If assembly is correct, each release spring is against a tooth on the clutch piston and the end is an inner disc.

(10) Insert all release springs (6) and guide pins (5). Install clutch disc end plate (2). Compress clutch disc end plate and install end plate snap ring (1).

y. Install input, reverse, third and fourth clutches as follows:

(1) Refer to figure 15-2.

(2) Insert lock ball (19) into outer race (18). Press outer race and ball assembly into clutch drum (20). Outer race must be pressed flush or one-sixty-fourth of an inch below shoulder in the clutch drum.

(3) Press support ball bearing (17) into clutch drum and secure with snap ring (15). From the rear end of the clutch drum, press support bearing (16) into the clutch drum and secure with snap ring (14).

(4) Install clutch drum assembly on clutch support (figure 15-1). Be careful not to damage clutch support piston rings.

(5) Install bearing washer (12) and snap ring (11). Install clutch piston inner ring (13) inside drum. Lubricate ring with transmission fluid. Install outer ring (10) in piston (9).

(6) Slide clutch piston (9) into position in the drum. Install baffle ring (4) on hub (3), and install the hub in the clutch drum.

(7) Install disc hub retainer ring (fig. 15-1, items 30 and 31).

(8) Install one inner disc (7) on disc hub and against clutch piston (9).

(9) Install one outer clutch disc (8) in clutch drum.

NOTE

The outer disc has teeth missing on the outer diameter to allow passage for the clutch release springs. Insert two or more release springs (6) in drum and against the teeth of the clutch piston. Install next inner disc. Alternate clutch discs, outer against inner, and always align the teeth on each outer disc with the teeth on the preceding outer disc. If assembly is correct, each release spring is against a tooth on the clutch piston and the end is an inner disc.

(10) Insert all release springs (6) and guide pins (5). Install clutch disc end plate (2). Compress the end plate and install end plate snap ring (1).

z. Refer to figure 15-1. Install filler plug (119), seal washer (118), and oil cap (117). Install elbow (115) and air breather (116). Assemble drive spring (20), drive bearing (23), snap rings (21) and (22) on drive shaft (24). Install the assembly in flexible shaft housing (18). Install a new gasket (19) on cover (14) and position the flexible shaft assembly on the cover. Secure the assembly with screws (16) and lock washers (17).

aa. Install a new gasket (15) on case (126) and position cover (14) on the transmission case. Install screw and washer sets (13) tighten screws to 20—25 ft-lb (27.1—33.9 N · m). Install new gasket (12) on transmission case (126) and position cover (11) on the case. Install screw and washer sets (10) and tighten the screws to 20—25 ft-lb (27.1—33.9 N · m).

ab. Install new gasket (9) on sump screen (8) and position the sump screen in the transmission case. Secure the screen with bolts (6) and lock washers (7). Tighten bolts to 20—25 ft-lb (27.1—33.9 N · m). Install washers in the sump pan. Install sump pan screw and washer sets (2). Tighten screws to 20—25 ft-lb (27.1—33.9 N · m). Install drain plug (1).

ac. Refer to figure 15-5 and reassemble the control cover as follows:

(1) Lubricate all parts with light coat of transmission fluid. Install seat (59), ball (58), spacer (57), spring (56), stop (54) and packing (55) in cover (62). Depress spring stop (54) and install spring stop roll pin (46). Install spool (53), packing (52) and stop (51).

(2) Install spool spring (50) inner spring (49) stop (47) and packing (48). Retain with roll pin (46).

(3) Install spring (32), packing (31), spring cap (30) and cap washer (29). Install valve (28) on the opposite side of the cover. Install piston (27) packing (26), piston guide (25) and spacer (24). Install snap ring (22) and adapter (23).

(4) Install valves (12) and (13) into valve housing (7). Install valve (6) into housing (7) and install valve pin stops (10). Secure with special washer (9) and plug (8). Install packings (11) and (5) on the valve housing and install the assembly into the control cover. Secure

with shift plug (4). Install selector valve (19), plug (18), snap ring (17) and packing (16). Insert spring (15) and secure with end plug (14).

(5) Install plugs (20), (34), (35), washers (21) and (36). Install spool (45), piston (44), packing (43) and secure with guide (42). Install pin (41), spring (40), valve stop (39), and packing (38). Depress the valve stop and install roll pin stop (37).

(6) Install plugs (33) and (61). Install oil circuit plate (3) and secure with screws (1) and lock washers

(2). Tighten screws to 10—15 ft-lb (13.6—20.3 N · m).
ad. Refer to figure 15-1 and install new packings (125). Install new gasket (124) and assembled control cover (123). Secure with screws (120) and (121) and lock washers (122). Tighten screws to 20—25 ft-lb (27.1—33.9 N · m).

15-6. Installation

Refer to paragraph 12-7 and install the transmission in the carrier.

Section II. REPAIR OF PROPELLER SHAFTS AND UNIVERSAL JOINTS

15-7. Description

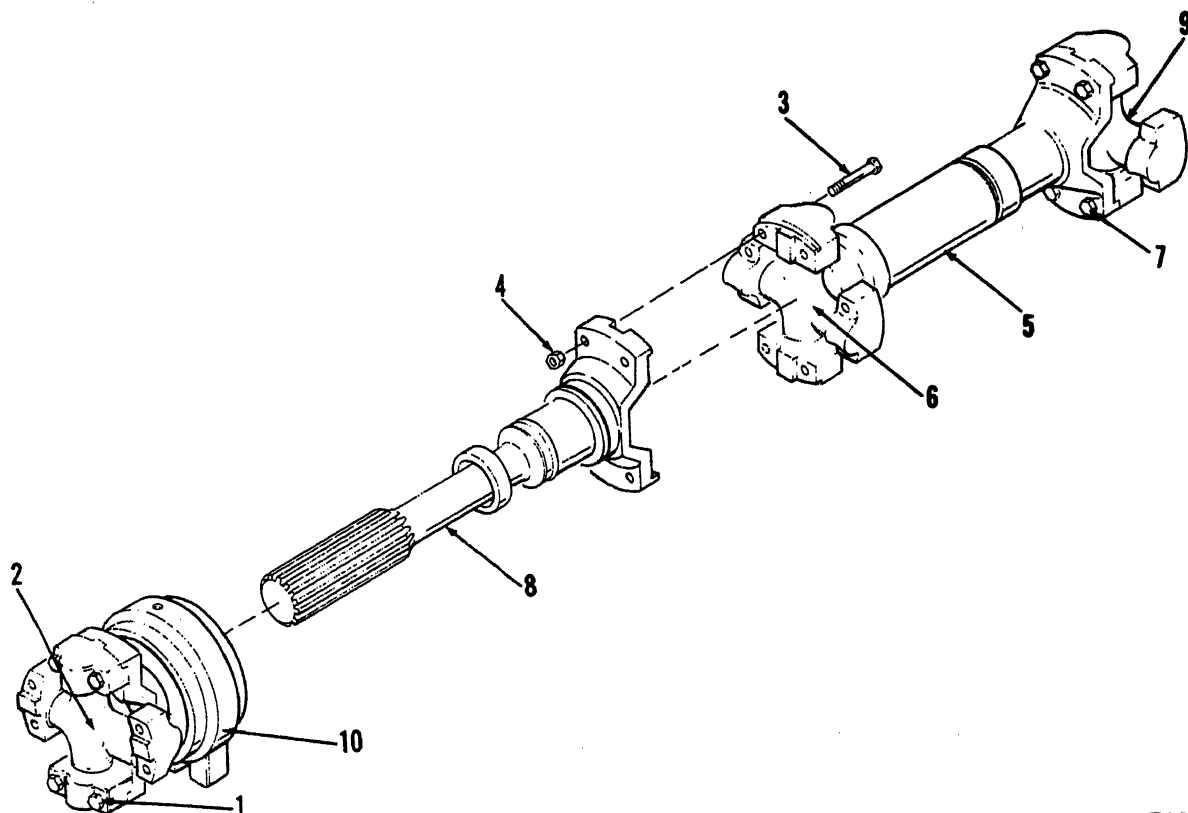
The carrier utilizes three propeller shafts; (1) front axle, (2) transmission and (3) rear axle. The front axle propeller shaft is a split shaft and therefore requires three universal joints. The transmission and rear axle shafts are equipped with two universal joints. The propeller shafts are of tubular type construction and each has one slip joint.

15-8. Removal and Disassembly

a. Refer to figures 15-7 and remove and disassemble

the front axle propeller shaft as follows:

- (1) Remove screws (1) and slide slip joint into shaft. Lift universal joint (2) off shaft (8).
- (2) Remove screws (3) and nuts (4), remove shaft (5) and universal joint (6).
- (3) Remove screws (7) and lift shaft (5) out. Remove universal joint (9).
- (4) Slide center bearing assembly (10) off shaft (8).



1 Screw
 2 Universal joint
 3 Screw
 4 Nut

5 Shaft
 6 Universal joint
 7 Screw

8 Shaft
 9 Universal joint
 10 Center bearing assembly

TA033304

Figure 15-7. Propeller shaft (transmission to front axle).

b. Refer to figure 15-8 and remove and disassemble the converter to transmission and the transmission to rear axle propeller shafts as follows:

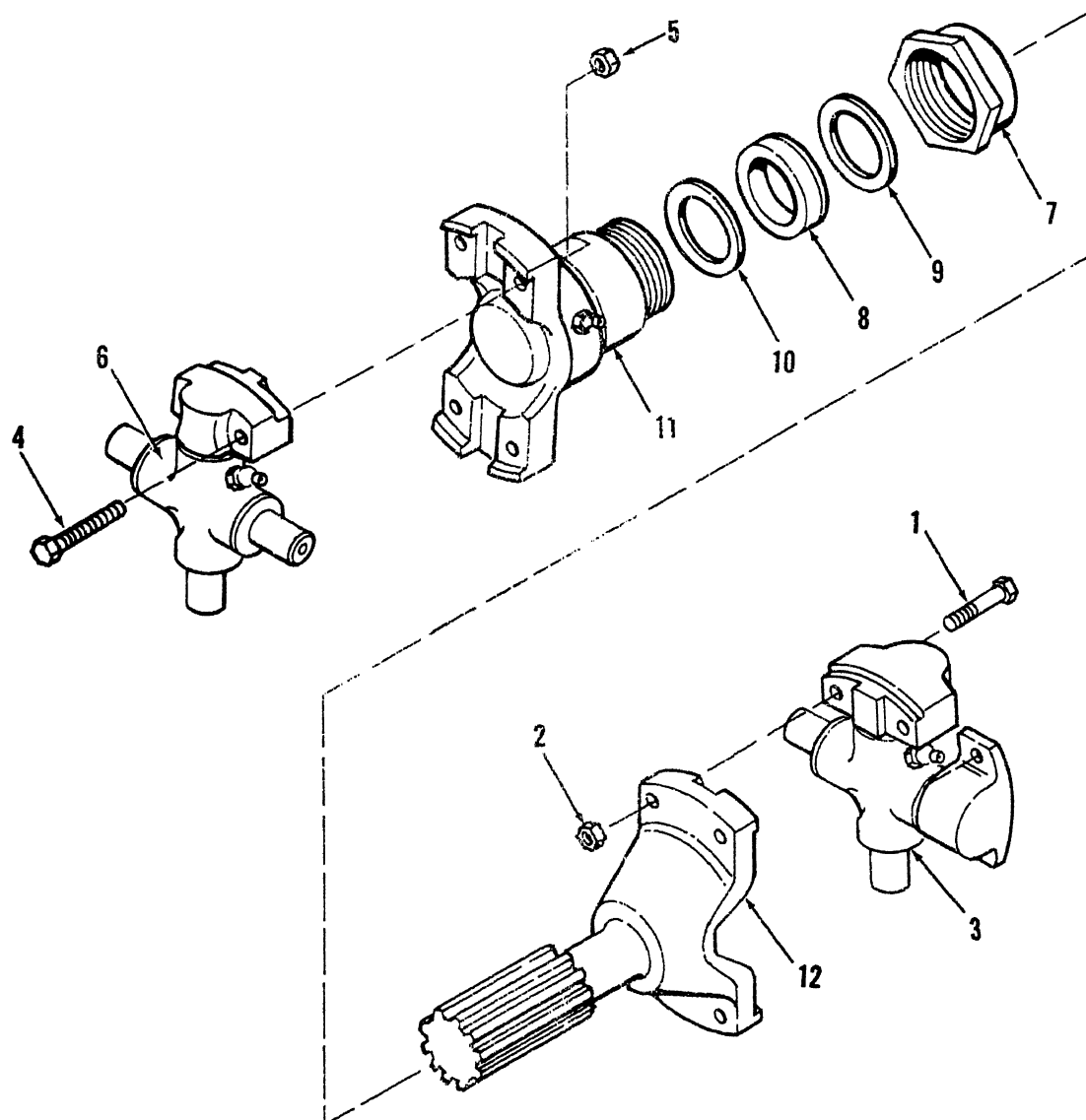
(1) Remove screws (1) and nuts (2), slide slip joint (12) back and remove universal joint (3).

(2) Remove screws (4) and nuts (5), remove univer-

sal joint (6). Lift propeller shaft assembly out of vehicle.

(3) Remove dust cap (7), felt washer (8) and washers (9) and (10).

(4) Separate splined yoke (11) and slip yoke (12).



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- 1 Screw
- 2 Nut
- 3 Universal joint
- 4 Screw
- 5 Nut
- 6 Universal joint
- 7 Dust cap
- 8 Felt washer
- 9 Washers
- 10 Washers
- 11 Splined yoke
- 12 Slip yoke

Figure 15-8. Propeller shaft (converter to transmission) and (transmission to rear axle).

15-9. Cleaning, Inspection and Repair

(1) Clean all metal parts with cleaning solvent (Federal Specification P-D-680, or equivalent) and dry thoroughly with compressed air.

(2) Inspect universal joints and propeller shift for excessive wear or damage. Replace all defective assemblies as required.

15-10. Reassembly and Installation

a. Refer to figure 15-7 and reassemble and install the transmission to front axle propeller shaft as described in the following:

- (1) Place center bearing assembly (10) on shaft (8).
- (2) Place universal joint (9) between the slip joint and front axle and secure with screws (7).
- (3) Place universal joint (6) between shaft (8) and

shaft (5) and secure with screws (3) and nuts (4).

(4) Slide center bearing assembly (10) on shaft (5) and install universal joint (2), secure with screws (1).

b. Refer to figure 15-8 and reassemble and install the converter to transmission and transmission to rear axle propeller shafts as follows:

(1) Install washer (10), felt washer (8), washer (9) and dust cap (7) on splined yoke (11). Snug tighten dust cap (7).

(2) Slide slip yoke (12) into splined yoke (11) being careful not to damage washers. Secure dust cover (7).

(3) Install universal joint (6) between splined joint and transmission. Secure with screws (4) and nuts (5).

(4) Install universal joint (3) between slip joint (12) and torque converter. Secure with screws (1) and nuts (2).

Section III. REPAIR OF CAB HYDRAULIC SHIFT CONTROL

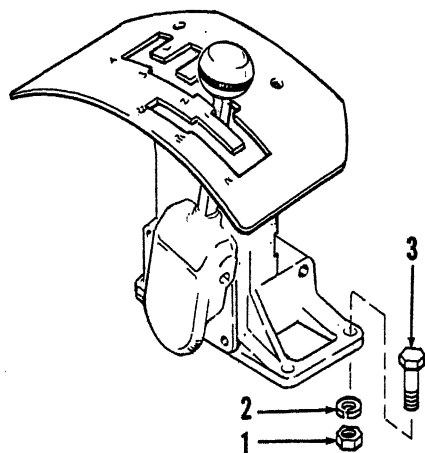
15-11. Description

The hydraulic shift control is one of the two separate valves which control the transmission. Hydraulic hoses connect the shift control valve (mounted in the cab) to the transmission control valve (mounted on the transmission). The shift control valve hydraulically positions a combination of valve spools in the transmission control cover. This enables the transmission control to engage the transmission in the range selected by the operator.

15-12. Removal and Disassembly

a. Refer to figure 15-9 and remove the hydraulic shift control as follows:

- (1) Tag and disconnect all hydraulic lines to the shift control.
- (2) Remove nuts (1), lockwashers (2) and cap screws (3). Lift shift control out of the cab assembly.



- 1 Nut
- 2 Lockwasher
- 3 Cap screw

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Figure 15-9. Hydraulic shift control removal.

b. Refer to figure 15-10 and disassemble the shift control as follows:

(1) Unscrew knob (1) from shift lever. Remove bolt (2), lock washer (3) and flat washer (4). Lift stop plate (5) of shift control.

(2) Remove set screw (6) and with a small drift remove roll pins (7) and (8). Pull lever housing (9) and bracket (10) from shift control.

(3) Remove bolts (11) and lock washers (12). Remove bearing cap (13) and gasket (14) from shift control housing.

(4) Remove oil seal (15) from bearing cap (13) being careful not to scratch bearing surface in cap.

(5) Remove pipe plug (16), spring (17) and check ball (18). Remove plug (19) by tapping from the inside with a drift and hammer.

(6) Remove selector shaft and bearing assembly by placing a drift through the expansion plug hole and tapping lightly.

(7) Remove retaining ring (20) and bearing (21) from pin assembly (22).

(8) Remove lock-up spool assembly from pin assembly (22) and remove oil seal (23).

(9) From lock-up spool (24) remove roll pin (25) and link (26). Punch plug (27) from housing (48).

(10) Remove selector plug (28), spring (29) and check ball (30) from valve housing.

(11) Remove check valve fitting (31), check ball (32) and spring (33) from valve housing.

(12) Remove neutral switch (34) and actuating pin (35) from housing (48).

(13) From the bottom of housing (48) remove selector spool and ring assembly. Remove link (36) from spool (38) by tapping roll pin (37) out with a small drift and hammer.

(14) Place a punch through plug opening in the bottom of housing (48) and punch plug (39) out of housing.

(15) Using a press, depress accumulator piston and spring assembly. Remove retaining ring (40) and slowly allow spring pressure to push stop (41) and piston (42) out of housing (48).

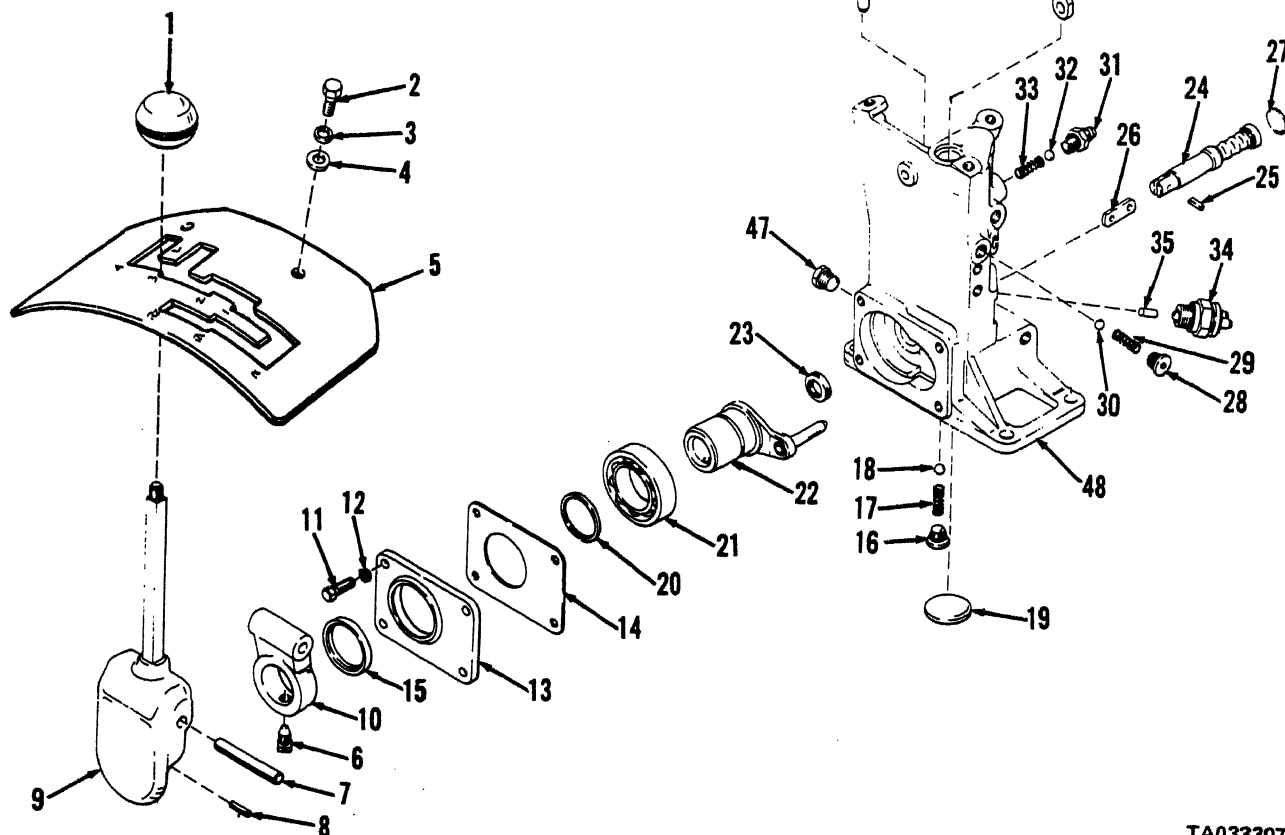
(16) Remove preformed packing (43) from valve

stop (41). Discard packing.

(17) Remove outer spring (44), inner spring (45) and piston stop pin (46).

(18) Remove pipe plug (47) from valve housing (48).

- | | |
|-------------------|------------------------|
| 1 Knob | 26 Link |
| 2 Bolt | 27 Expansion plug |
| 3 Lock washer | 28 Selector plug |
| 4 Flat washer | 29 Spring |
| 5 Stop plate | 30 Check ball |
| 6 Set screw | 31 Check valve fitting |
| 7 Roll pin | 32 Check ball |
| 8 Roll pin | 33 Spring |
| 9 Lever housing | 34 Neutral switch |
| 10 Bracket | 35 Actuating pin |
| 11 Bolt | 36 Selector link |
| 12 Lock washer | 37 Roll pin |
| 13 Bearing cap | 38 Selector spool |
| 14 Gasket | 39 Expansion plug |
| 15 Seal | 40 Retaining ring |
| 16 Pipe plug | 41 Valve stop |
| 17 Spring | 42 Piston |
| 18 Check ball | 43 Preformed packing |
| 19 Expansion plug | 44 Outer spring |
| 20 Retaining ring | 45 Inner spring |
| 21 Bearing | 46 Piston stop pin |
| 22 Pin assembly | 47 Pipe plug |
| 23 Seal | 48 Valve housing |
| 24 Lock-up spool | |
| 25 Roll pin | |



TA033307

Figure 15-10. Hydraulic shift control.

15-13. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent (Federal Specification P-D-680, or equivalent), dry thoroughly with compressed air.

b. Inspect all parts for cracks, scoring corrosion, excessive wear or other defects.

c. Replace all gaskets, preformed packing and damaged or defective parts.

15-14. Reassembly and Installation

a. Refer to figure 15-10 and reassemble the hydraulic shift control as follows:

(1) Install pipe plug (47) in valve housing (48).

(2) Place piston stop pin (46), inner spring (45) and outer spring (44) into housing (48).

(3) Install new preformed packing (43) on valve stop (41) and place piston (42) and valve stop (41) on top of springs (44) and (45).

(4) Using a press for consistent pressure, depress valve stop (41), piston (42) and spring (44) and (45). Install retaining ring (40) and slowly release pressure on accumulator assembly.

(5) Install selector link (36) on selector spool (38) with roll pin (37). Place selector spool assembly in housing (48) and top expansion plug (39) in place evenly and securely.

(6) Press new seal (23) in pin assembly (22). Lip of seal (23) must be facing away from bearing (21).

(7) Press bearing (21) on shaft of pin assembly (22) and install retaining ring (20).

(8) Install selector shaft, pin and bearing assembly in housing (48). Pin on pin assembly (22) must be inserted in selector link (36).

(9) Install lock-up link (26) on spool (24) with roll

pin (25) and insert lock-up spool assembly in housing (48).

CAUTION

When inserting lock-up spool assembly do not damage oil seal (23).

(10) Install expansion plug (27) securely in housing (48).

(11) Install neutral actuating pin (35) and neutral switch (34) in housing (48).

(12) Place spring (33), check ball (32) and check valve fitting (31) in housing (48).

(13) Install speed selector check ball (30), spring (29) and selector plug (28) in housing (48).

(14) Install expansion plug (19) in housing (48) by tapping lightly with a soft headed hammer.

(15) Install check ball (18), spring (17) and lock-up pipe plug (16) in housing (48).

(16) Install new seal (15) in bearing cap (13). Lip of seal (15) must be facing away from bearing (21).

(17) Assemble gasket (14) and bearing cap (13) on housing (48) and secure with lock washers (12) and bolts (11).

(18) Place bracket (10) on selector shaft. Install lever housing (9), aligning it with selector link (26). Secure with roll pins (7) and (8) and set screw (6).

(19) Install stop plate (5). Secure with flat washers (4), lock washers (3) and bolts (2).

(20) Screw knob (1) on lever shaft.

b. Refer to figure 15-9 and install hydraulic shift control in carrier cab as follows:

(1) Set control in position and secure with bolts (3), lock washers (2) and nuts (1).

(2) Reconnect all hydraulic lines as tagged in the removal procedure.

Section IV. REPAIR OF TORQUE CONVERTER**15-15. General**

The engine rotation is carried to the transmission by the torque converter shaft. Oil-activated clutches in the transmission engage gears of the inner and outer trains to obtain the gear ratio selected by the shift lever in the carrier cab. The rotation from the transmission is transferred to the front and rear drive axles by the drive shafts. Rotation then goes through the differential to a planetary in each drive wheel. As the speed of the torque converter output shaft approaches 1800 rpm, the converter automatically locks

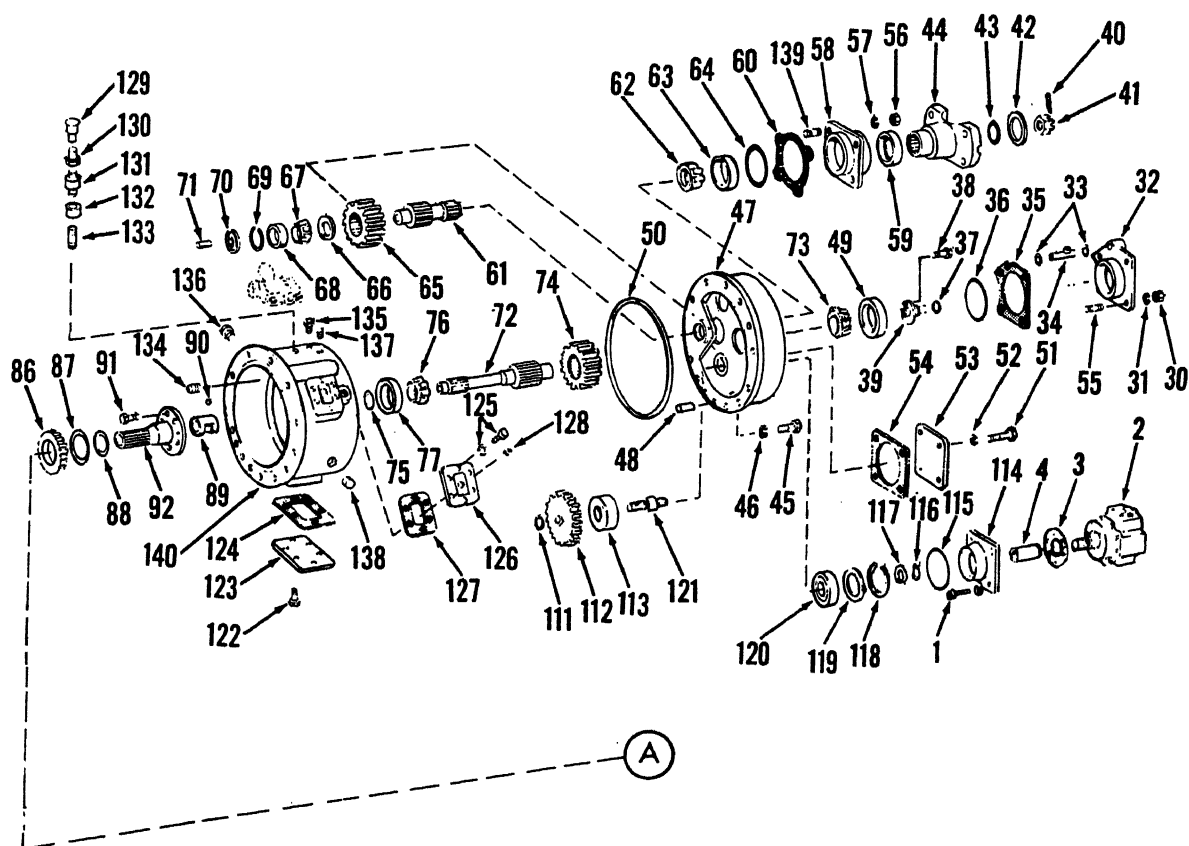
in whatever gear the transmission is in, thus assuring maximum efficiency from the converter. The lockup automatically disengages when the converter speed drops or whenever the transmission is shifted.

15-16. Removal and Disassembly

a. *Removal.* Refer to paragraph 12-6b. and remove the engine and torque converter as described.

b. *Disassembly.* Refer to figure 15-11 and disassemble the torque converter as follows:

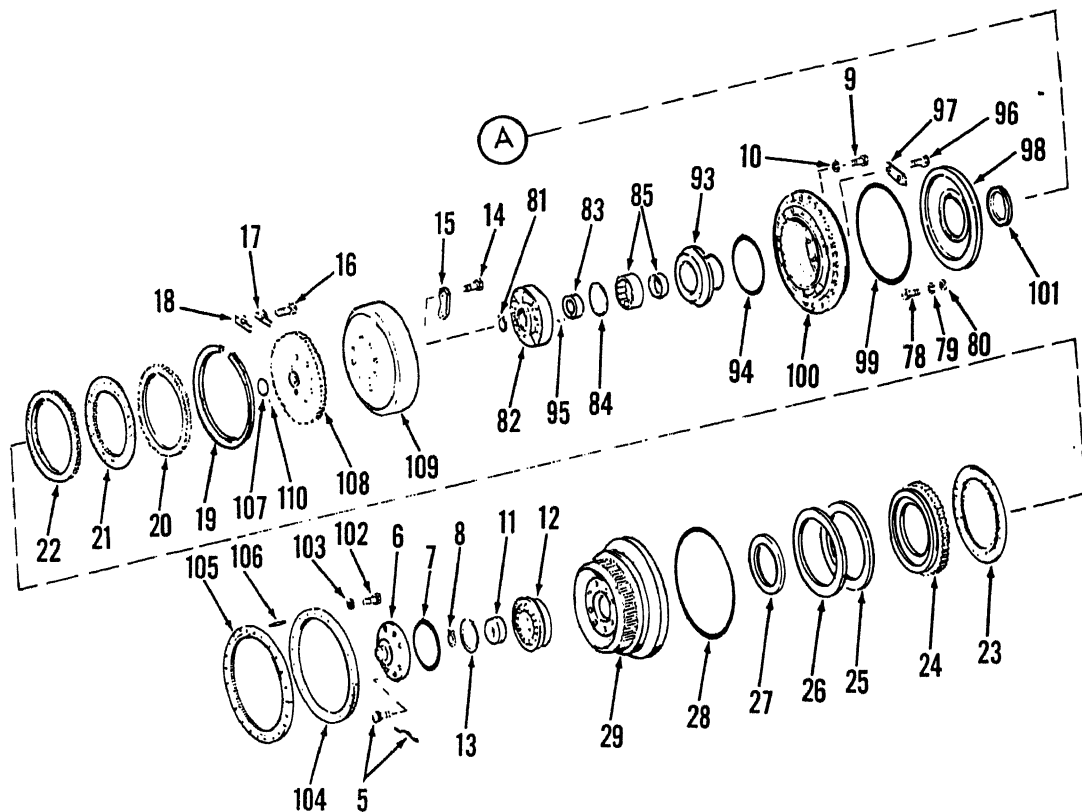
(1) Remove screw and lock washer (1), pump assembly (2), gasket (3) and drive sleeve (4).



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- | | | | | |
|------------------------|----------------------|----------------------|----------------------|---------------------|
| 1 Lock washer w/screws | 29 Impeller cover | 57 Lock washer | 85 Bearing | 113 Bearing |
| 2 Pump assembly | 30 Nut | 58 Bearing cap | 86 Gear | 114 Adapter |
| 3 Gasket | 31 Lock washer | 59 Oil seal | 87 Retaining ring | 115 Gasket |
| 4 Drive sleeve | 32 Bearing cap | 60 Shims | 88 Piston ring | 116 Ring |
| 5 Cap screw | 33 Preformed packing | 61 Shaft | 89 Sleeve | 117 Washer |
| 6 Bearing cap | 34 Lube tube | 62 Bearing cone | 90 Ball | 118 Retaining ring |
| 7 Preformed packing | 35 Shim | 63 Bearing cup | 91 Cap screw | 119 Washer |
| 8 Retaining ring | 36 Preformed packing | 64 Preformed packing | 92 Sleeve | 120 Bearing |
| 9 Cap screw | 37 Piston ring | 65 Gear | 93 Hub | 121 Drive shaft |
| 10 Lock washer | 38 Cap screw | 66 Spacer | 94 Preformed packing | 122 Cap screw |
| 11 Retainer | 39 Adapter | 67 Bearing cone | 95 Roll pin | 123 Cover |
| 12 Bearing | 40 Cotter pin | 68 Bearing cup | 96 Cap screw | 124 Gasket |
| 13 Piston ring | 41 Nut | 69 Retaining ring | 97 Lock plate | 125 Screws w/washer |
| 14 Special bolts | 42 Washer | 70 Baffle | 98 Baffle | 126 Cover |
| 15 Lock plate | 43 Preformed packing | 71 Oil tube | 99 Preformed packing | 127 Gasket |
| 16 Cap screw | 44 Flange | 72 Turbine shaft | 100 Impeller | 128 Vent plug |
| 17 Lock plate | 45 Cap screw | 73 Bearing cone | 101 Oil seal | 129 Breather |
| 18 Plate | 46 Lock washer | 74 Gear | 102 Cap screw | 130 Bushing |
| 19 Retaining ring | 47 Housing cover | 75 Piston ring | 103 Washer | 131 Check valve |
| 20 Backing plate | 48 Dowel | 76 Bearing cone | 104 Plate | 132 Coupling |
| 21 Inner disc | 49 Bearing cup | 77 Bearing cup | 105 Ring gear | 133 Nipple |
| 22 Outer disc | 50 Preformed packing | 78 Cap screw | 106 Stud | 134 Pipe plug |
| 23 Inner disc | 51 Cap screw | 79 Lock washer | 107 Retaining ring | 135 Pipe plug |
| 24 Lock-up piston | 52 Lock washer | 80 Washer | 108 Hub | 136 Pipe plug |
| 25 Piston ring | 53 Cover | 81 Retaining ring | 109 Turbine | 137 Pipe plug |
| 26 Seal | 54 Gasket | 82 Reaction member | 110 Dowel | 138 Pipe plug |
| 27 Piston ring | 55 Stud | 83 Spacer | 111 Retaining ring | 139 Stud |
| 28 Preformed packing | 56 Nuts | 84 Retaining ring | 112 Gear | 140 Housing |

Figure 15-11. Torque converter assembly—exploded view (sheet 1 of 2).



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Figure 15-11. Torque converter assembly—exploded view (sheet 2 of 2).

(2) Remove screws (5). Install two bolts in threaded holes of bearing cap (6). Turn the bolts evenly and remove bearing cap (6), preformed packing (7), and retaining ring (8).

(3) Remove screws (9) and lock washers (10). Using a suitable puller remove bearing retainer (11), bearing (12), piston ring (13) from turbine shaft (72).

(4) Remove bolts (14) and lock plate (15) from turbine (109).

CAUTION

Secure impeller cover (29) with a chain to prevent assembly from dropping.

(5) Block impeller cover (29) on the outer diameter and drive turbine hub and cover assembly from shaft (72).

(6) Straighten tangs on lock plates (17) and remove screws (16), lock plates (17) and plates (18)

from cover.

(7) Remove retaining ring (19), backing plate (20), inner disc (21), outer disc (22), inner disc (23), and lockup piston (24).

(8) Remove piston ring (25), plastic seal (26), piston ring (27), and preformed packing (28) from impeller cover (29).

(9) Remove nut (30) and lock washer (31) and lift bearing cap (32) off cover (47). Remove preformed packing (33), lube tube (34), shim (35) and preformed packing (36).

(10) Remove piston ring (37) from adapter (39). Remove cap screw (38) and install two bolts in threaded holes of adapter (39). Turn bolts evenly to remove adapter (39) from cover (47).

(11) Using a soft bar, lock output gears (65) and remove cotter pin (40) and nut (41). Remove washer

(42) preformed packing (43) and flange (44).

(12) Remove rear housing cover cap screws (45) and lock washers (46). Pull housing cover (47) from the housing.

(13) Remove dowel pin (48), bearing cup (49) and packing (50) from cover (47). Remove cap screws (51), lock washers (52), cover (53) and gasket (54) from cover (47). Remove stud (55).

(14) Remove nuts (56), lock washers (57), bearing cap (58) oil seal (59) and shims (60). Using a split puller remove shaft (61) and bearing cone (62). Remove bearing cup (63) and packing (64).

(15) Remove output gear (65), spacer (66), bearing cone (67) bearing cup (68), ring (69), baffle (70) and oil tube (71) from the rear cover.

(16) Remove turbine shaft assembly (72) and remove bearing cone (73), gear (74), ring (75) and bearing cone (76) from shaft. If required pull bearing cup (77) from housing (140).

(17) Remove cap screws (78), lock washers (79) and washers (80) from housing (140). Remove retaining ring (81) and remove reaction member (82) and spacer (83).

(18) Remove retaining ring (84), and bearing (85) from sleeve assembly. Remove hub and impeller assembly from sleeve (92).

(19) Remove gear (86), retaining ring (87) and piston ring (88) from sleeve (92). Remove sleeve (89) and ball (90) from sleeve (92). Remove cap screws (91) and remove sleeve (92) from housing (140).

(20) Remove hub (93) from impeller and baffle assembly and remove packing (94). Remove roll pin (95) from spacer (84).

(21) Remove cap screws (96), lock plate (97), baffle (98), and packing (99) from impeller (100). Remove oil seal (101) from baffle (100).

(22) Remove cap screws (102) and washers (103) and remove plate (104) and ring gear (105) from impeller (100). Remove studs (106) from ring gear (105).

(23) Remove retaining ring (107) and hub (108) from turbine (109). Remove dowels (110) from hub (108) as necessary:

(24) Remove retaining ring (111), gear (112), and bearing (113) from drive shaft (121). Remove adapter (114) and gasket (115). Remove ring (116), washer (117), ring (118), washer (119) and bearing (120). Gently tap shaft (121) out of housing (47).

(25) Remove cap screws (122) and remove cover (123) and gasket (124) from housing (140). Remove screws and washers (125) and remove cover (126) and gasket (127) from housing (140). Remove vent plug (128) from cover (126).

(26) Remove breather (129), bushing (130), check valve (131), coupling (132) and nipple (133) from housing (140). Remove pipe plugs (134, 135, 136, 137 and 138) from housing (140).

(27) Remove studs (139) from cover (47).

15-17. Cleaning, Inspection and Repair

a. Clean all parts of the torque converter assembly with cleaning solvent, Federal Specification P-D-680 or equivalent, and dry thoroughly.

b. Inspect bearings, cages and cups for wear, chipping or nicks. Replace defective or damaged bearings, both cone and cup as a set.

c. Inspect gears and shafts with magnetic inspection. Inspect all gears for wear, pitting, chipping, nicks, cracks, or scoring. Replace defective gears.

d. Inspect shafts and quills to make certain they are not sprung, bent, or have twisted splines. Replace defective shafts.

e. Inspect housing, covers, and bearing caps and see that mating surfaces, bearing bores, etc., are free from nicks or burrs. Check all parts carefully for evidence of cracks or conditions which would cause subsequent oil leaks or failures. Repair or replace defective parts.

f. Replace all spring loaded oil seals, preformed packing, metal sealing rings, gaskets and retaining rings.

15-18. Reassembly and Installation

a. Refer to figure 15-11 and reassemble the torque converter assembly as follows:

(1) Install sleeve (92) and secure with cap screws (91). Torque cap screws to 70—85 ft-lb (94.9—115.2 N • m).

(2) Place gear (112) in position in cover (47). Install pump shaft (121) and bearing (113) through rear of cover (47) into gear (112), secure with retaining ring (111). Install bearing (120), washer (119), and retaining ring (118).

(3) Apply a thin coat of No. 2 Permatex, or equivalent, to outer diameter of oil seal (101) and press into bore of baffle (98). Lip of seal must be upward. Install packing (94) and hub (93) secure with lock plate (97) and cap screws (96).

(4) Install baffle (98) on hub and impeller assembly. Install gear (86), retaining ring (87) and piston ring (88).

(5) Install impeller and baffle assembly into converter housing (140) over sleeve (92). Use caution not to damage baffle packing. Install bearing (85) and retaining ring (84). Press roll pin (95) in reaction member (82) and press spacer (83) on roll pins. Install reaction member (82) on sleeve (92) and secure with retaining ring (81). Install washers (80), lock washers (79) and cap screws (78) to secure baffle and impeller assembly to housing (140).

(6) Install ball (90) and sleeve (89) in sleeve (92) through housing (47). Install bearing cup (77) into housing (47). Install bearing cone (76), piston ring (75), and gear (74) on shaft (72).

(7) Block converter housing (140) on pilot end and

install shaft assembly (72) in the housing. Install bearing cup (68) in cover (47) and place gear (65), spacer (66) and bearing cone (67) in the proper position in the cover. Press bearing cone (62) on shaft (61). Install shaft (61) through cover into gear (65), secure with retaining ring (69). Install baffle (70) and oil tube (71).

(8) Press oil seal (59) into bearing cap (58) with lip of seal down. Install new preformed packing (64) on bearing cap (58) and install bearing cap on shaft (61). Install studs (139) in cover (29) and secure bearing cap (58) tight to cover with lock washers (57) and nut (56) to insure seating of tapered bearings. Loosen nuts (56) and retighten only finger tight evenly. Measure gap between bearing cap (58) and cover (29). Subtract 0.002 inch from gap dimension, this indicates the required shims necessary to maintain a 0.002 in "tight condition." Install shims (60), as determined above, under bearing cap (58) and secure with lock washers (57) and nuts (56). Torque nuts (56) to 47—55 ft-lb (63.7—74.6 N • m).

(9) Install new packing (50) and dowels (48). Connect rear cover (47) to housing (140), secure with lock washers (46) and cap screws (45). Torque cap screws (45) to 35—45 ft-lb (47.5—61.0 N • m).

(10) Using a soft bar, lock output gear (65) and install flange (44), packing (43), washer (42) and nut (41). Torque nut to 250—300 ft-lb (338.9—406.7 N • m). Install cotter pin (40).

(11) Install bearing (49) in bearing cap (32). Install studs (55) in housing (140) if removed.

(12) Place bearing cap (32) on housing (140) and tighten securely with nuts (30) to insure proper seating of tapered bearings. Loosen nuts (30) and retighten evenly finger tight. Measure gap between bearing cap (32) and housing (140). Add 0.002 inch to measured gap to supply a 0.002 in loose condition of bearings. Install shims (35) equal to the measured gap plus 0.002 inch.

(13) Remove bearing cap (32) and install adapter (39) and ring (37) on shaft (72) secure with cap screws (38). Torque to 20—25 ft-lb (27.1—33.8 N • m). Install new packing (33) on lube tube (34). Using bearing cap as a guide for lube tube flange, install packing (36) in position and reinstall bearing cap (32). Secure using lock washers (31) and nuts (30), torque to 47—55 ft-lb (63.7—74.5 N • m).

(14) Install gasket (54) and cover (53) on housing (140), secure with lock washers (52) and cap screws (51).

(15) Install piston ring (27), seal (26), piston ring (25), and lock-up piston (24) in impeller cover (29). Install bronze inner disc (23) against lock-up piston (24). Install steel outer disc (22) and place bronze inner disc (21) against it. Install backing plate (20) with flat side against inner disc (21) secure plate with retaining ring (19). Split in retaining ring (19) must be at backing plate position. Install plate (18), lock plate (17), and

cap screws (16). Torque to 10 ft-lb (13.6 N • m) and bend tangs of lock plate (17) over cap screws (16).

(16) Install dowels (110), hub (108) and retaining ring (107) on turbine (109). Secure with lock plate (15) and special bolts (14). Install turbine (109) and hub (108) in impeller cover (29). Turn turbine slowly to allow lock-up hub to engage in inner lock-up discs. Do not force this operation. When turbine is in full position in lock-up discs, turn assembly over and block turbine to prevent it from dropping out of position.

(17) Install new packing (28) on impeller (100). Install turbine and cover on shaft (72) aligning holes in cover (29) with holes in impeller (100). Secure with cap screws (9) and lock washers (10). Tighten cap screws evenly and securely.

(18) Install bearing (12), retainer (11), retaining ring (8), and piston ring (13) on shaft (72). Place new packing (7) in bearing cap (6) and install bearing cap (6) on cover (29). Secure with cap screws (5). Torque cap screws to 45—60 ft-lb (61.0—81.3 N • m) and lock wire.

(19) Install washer (117) and ring (116) on drive shaft (121). Install new packing (115) on adapter (114) and install adapter to cover (47). Install sleeve (4), gasket (3) and pump (2) on cover (47) secure with lock washers and screws (1). Tighten securely.

(20) Install studs (106) to ring gear (105). Install ring (105) and plate (104) to impeller (100). Secure with lock washers (103) and cap screws (102). Tighten securely.

(21) Install gasket (124) and cover (123) to housing (140). Secure with cap screw (122). Install vent plug (128) to cover (126) and install gasket (127) and cover (126) to housing (140). Secure with screws with lock washers (125).

(22) Install nipple (133), coupling (132), check valve (131), bushing (130) and breather (129) to housing (140). Install pipe plugs (138, 137, 136, 135 and 134) in housing (140).

b. Installation. Refer to paragraph 12-6c. and install the torque converter and engine as described.

15-19. Service

a. The torque converter, transmission and its allied hydraulic system are important links in the drive line between the engine and the wheels. The proper operation of either unit depends greatly on the condition and operation of the other, therefore, whenever repair or overhaul of one unit is performed, the balance of the system must be considered before the job can be considered completed.

b. After the overhauled or repaired torque converter has been installed in the machine, the transmission, oil cooler, filter and connecting hydraulic system must be thoroughly cleaned. This can be accomplished in several manners and a degree of judgment must be exercised as to the method employed.

c. The following are considered the minimum steps

to be taken:

(1) Drain the entire system thoroughly.

(2) Disconnect and clean all hydraulic lines. Where feasible hydraulic lines should be removed from machine for cleaning.

(3) Replace oil filter elements, cleaning out filter cases thoroughly.

(4) The oil cooler must be thoroughly cleaned. The cooler should be "back flushed" with oil and compressed air until all foreign material has been removed. Flushing in direction of normal oil flow will not adequately clean the cooler. If necessary radiator and cooler assembly should be removed from machine for cleaning, using oil, compressed air and steam cleaner for that purpose. DO NOT use flushing compounds for cleaning purposes.

(5) Remove transmission sump pump and screen. Clean thoroughly. Use new gasket when reassembling.

(6) Remove clutch covers and clutch assemblies. Clean disassembled clutch components thoroughly, check for wear.

(7) Remove transmission control cover and check it for foreign material. Check inside of transmission case, gears, shafts and bearings for presence of foreign materials. If presence of considerable foreign material is noted inside of case and clutch components, it will be necessary that transmission be disassembled and cleaned thoroughly. DO NOT attempt to clean by use of flushing compounds.

(8) Reassemble all components and using oil specified in the Lubrication Order, fill torque converter and transmission through filler opening until fluid comes up to FULL mark on transmission dipstick. Reinstall fill plug and dipstick and run engine two minutes at 500—600 rpm to prime torque converter and hydraulic lines. Recheck level of fluid in transmission with engine running at idle (500—600 rpm) and add quantity necessary to bring level up to FULL mark on dipstick. Recheck with hot oil (180° to 200°).

(9) Recheck all drain plugs, lines, connections etc., for leaks and tighten where necessary.

CHAPTER 16 REPAIR OF AXLES

Section I. WHEEL AND TIRE

16-1. General

The carrier is equipped with four 26.5x25 (26-ply) tubeless tires. All rims and tires on the carrier are interchangeable and can be mounted on either axle.

16-2. Removal

Refer to TM 5-3810-295-12 and remove wheel and tire assembly as described.

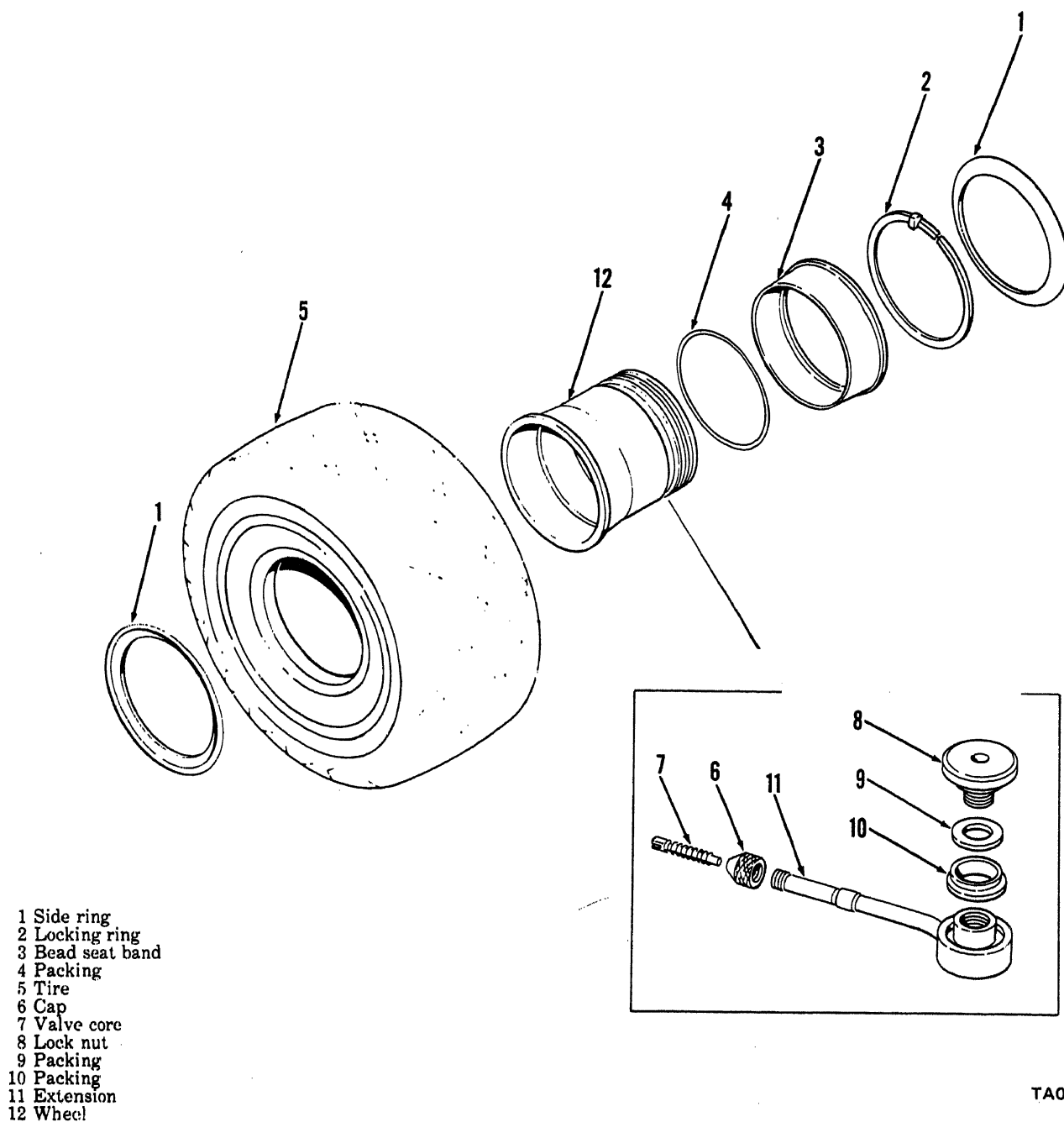


Figure 16-1. Carrier wheel and tire assembly—exploded view.

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16-3. Disassembly

- a. Remove air from tire. Using a suitable pneumatic tire tool, break tire (5) from the rim.
- b. Remove slide rings (1) and locking ring (2). Remove bead seat band (3) and packing (4). Remove tire (5).
- c. If necessary, remove cap (6) and valve core (7). Then remove lock nut (8), packing (9) and (10), and remove extension (11) from wheel (12).

16-4. Cleaning, Inspection and Repair

- a. Clean all metal parts with cleaning solvent, Federal Specification P-D-680, or equivalent, before inspection. Be sure all seating surfaces are clean and free of rust.

- b. Inspect the rim assembly for cracks, breaks, or other damage.
- c. Replace all packing.
- d. Replace all defective parts.

16-5. Reassembly and Installation

- a. Refer to figure 16-1. Assemble valve stem parts (6 through 11) on rim (12).
- b. Install tire (5) on the rim. Install new packing (4) on bead seat band (3) and install seat band (3) on the rim.
- c. Install locking ring (2) and slide rings (1). Inflate tire to 50 psi.
- d. Install wheel assembly on the axle as described in TM 5-3810-295-12.

Section II. DRIVE STEER AXLES

16-6. General

Both front and rear axles are combination drive and steer types. Power is delivered to the wheels through the differential and axle shafts. The front axle may be disengaged to rotate freely by the operator. The front axle uses a conventional differential unit. The rear axle is equipped with a "no spin" differential unit for rough terrain.

16-7. Removal

- a. Refer to paragraph 12-8 and remove the axle assembly from the carrier.

- b. Clean the exterior of the assembly thoroughly to prevent dirt and foreign materials from entering the mechanism.

- c. Place the assembly on suitable steel horses, in an inverted position, to facilitate disassembly.

16-8. Disassembly

- a. Refer to figure 16-2 and remove drain plugs (1) and (2) to drain axle. Remove tie rod nuts (3), bolts (4), and tie rod (5). Remove lubrication fitting (6). Press bushings (7) from tie rods.

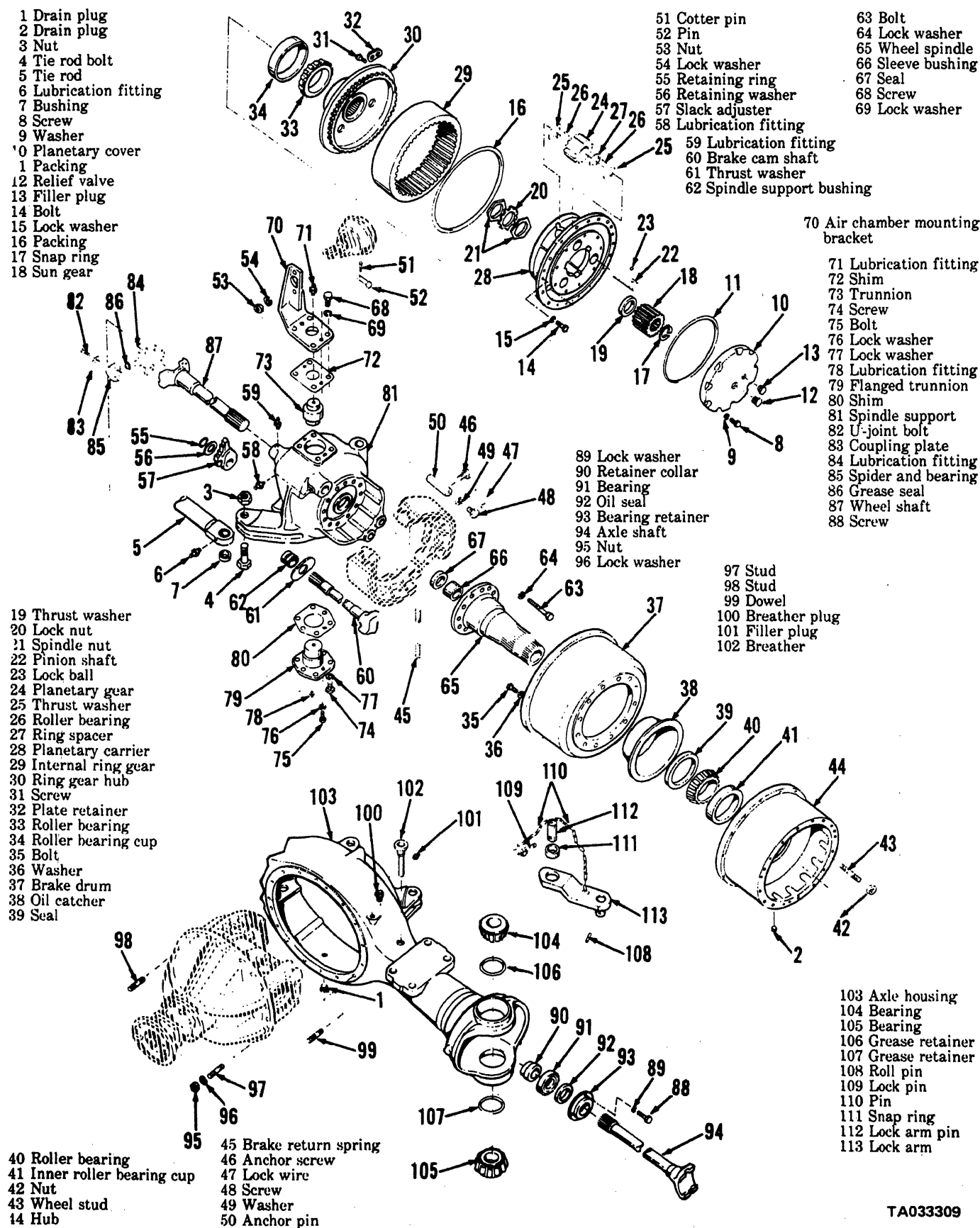


Figure 16-2. Axle assembly—exploded view.

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b. Remove screws (8) and washers (9) securing planetary cover (10). Remove cover (10) and packing (11). Remove relief valve (12) and filler plug (13) from the cover.

c. Remove bolts (14) and lock washers (15) securing the planetary carrier. Install three mounting bolts (14) in puller holes provided to pull planetary carrier from the hub assembly. Remove planetary as an assembly. Remove packing (16) from the assembly.

d. Remove sun gear retaining snap ring (17). Using a suitable puller, remove sun gear (18) and thrust washer (19). Straighten tabs on lock nut (20) and remove spindle nuts (21) and lock nut (20).

e. Place planetary carrier assembly in a press, gear side up and press out pinion shaft (22). Catch lock balls (23) as the shafts are pressed out. Carefully remove planetary gears (24), thrust washers (25), pinion rollers (26) and spacers (27), from planetary carrier (28).

f. Support the weight of the brake drum and hub assembly with a hoist. Remove internal ring gear (29) and hub (30) from the spindle assembly. It may be necessary to use pry bars through the holes provided in the hub.

g. If replacement of internal ring gear is necessary, remove screws (31) and plate retainers (32). Lift hub (30) from ring gear (29). If bearing cone (33) is damaged, drive cone (33) and cup (34) from hub (30).

h. Using a suitable hoist and chain, pull the brake drum and hub assembly straight out from the axle.

NOTE

Be sure brake shoes are in the fully released position.

i. Match mark hub (44) and drum (37) to assure proper reassembly. Remove bolts (35) and washers (36) securing brake drum to hub. Remove oil catcher (38) and pry out seal (39).

j. Lift out bearing cone (40). If replacement of bearing cups (41) is necessary, drive the cups out using a soft drift. Take care to avoid damage to the bearing bores. Remove nuts (42) and wheel studs (43) from hub (44).

NOTE

If any wheel studs are damaged, all must be replaced.

k. Remove brake return spring (45). Remove anchor screws (46), lock wire (47), screw (48), washer (49), and anchor pin (50). Remove brake shoe assembly.

CAUTION

Support brake shoes or they may pivot about the anchor pin when the spring is released.

l. Remove cotter pin (51), pin (52), nuts (53) and lock washers (54) securing air chamber to air chamber bracket. Remove air chamber.

m. Remove slack adjuster retaining ring (55) and retaining washer (56). Using a plastic hammer, drive slack adjuster (57) from the brake camshaft. Remove

lubrication fittings (58) and (59).

n. Remove brake camshaft (60) and thrust washer (61). Drive bushing (62) from spider.

o. Remove bolts (63) and lock washers (64). Remove spindle (65), bushing (66) and seal (67).

p. Remove screws (68), lock washers (69) and air chamber bracket (70). Remove lubrication fitting (71), shims (72) and trunnion (73).

q. Support weight of spindle support (81) with a hoist. Remove trunnion attaching screws (74), bolts (75) and lock washers (76) and (77). Remove lubrication fitting (78). Using two puller bolts, pull trunnion (79) and shims (80) from spindle support (81). Remove spindle support (81) from the axle housing.

r. Remove U-joint bolts (82) and coupling (83). Remove assembled U-joint and wheel end axle shaft. Remove lubrication fitting (84), spider and bearing (85) and grease seal (86). Remove wheel end axle shaft (87).

s. Remove bearing retainer screws (88) and lock washers (89). Remove assembled differential end axle shaft, bearing, retainer, seal and collar from the axle housing. Remove collar (90), bearing (91), oil seal (92), bearing retainer (93) and axle shaft (94). Disassemble the opposite side of the axle in the same manner.

t. Support weight of the differential with a hoist. Remove nuts (95), lock washers (96) studs (97) and (98), and dowel (99). Carefully remove the differential from the housing lightly with a soft mallet to break the seal. Refer to paragraph 16-14 for disassembly procedures for the differentials.

u. Remove breather plug (100), filler plug (101), and breather (102) from axle housing (103).

v. Remove bearings (104) and (105), and retainers (106) and (107).

w. For the rear axle only, remove roll pin (108), lock pin (109), pin (110), snap ring (111), lock arm pin (112) and lock arm (113).

16-9. Cleaning, Inspection and Repair

a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent, before inspecting.

b. Replace all seals and packing.

c. Inspect all rollers, cages and cups for wear, chipping or nicks. Do not replace a bearing cone or cup individually without replacing the mating cup or cone. After inspection, dip bearings in light oil and wrap in clean, lintless cloth or paper.

d. If possible, check all gears and shafts using the magnaflux process. Examine teeth and ground and polished surfaces for wear, pitting, chipping, nicks, cracks and scores. Replace all gears having cracked or chipped teeth. Small nicks may be removed with a suitable hone. Inspect shafts to assure that they are not sprung, bent, or have twisted splines, and that shafts are true.

e. Inspect wheel studs for indications of elongation and wear. Wheel studs must be replaced as a set.

f. Inspect housings, covers and planet carrier to assure they are thoroughly cleaned and that mating surfaces, bearing bores and sealing surfaces are free from nicks and burrs. Check all parts for cracks or conditions which would cause subsequent oil leaks or failures.

g. Replace brake shoe return springs.

h. Inspect brake drums for cracks, heat checks, scoring or other damage. If drum internal diameter exceeds 20.25 inches, replace the drum.

16-10. Reassembly

a. Refer to figure 16-2. On rear axle assembly, install lock arm (113), lock arm pin (112), snap ring (111), pin (110), lock pin (109) and secure with roll pin (108).

b. Install breather (102), filler plug (101) and breather plug (100) in axle housing (103).

c. If differential has been removed, install dowel (99), studs (98) and (97). Apply a thin coating of Permatex No. 2 to mating surfaces and install differential and carrier assembly and secure with lock washers (96) and nuts (95).

d. Apply a light coating of Permatex No. 2 to the flange of grease retainers (106) and install grease retainers in the upper trunnion bearing bore. Wipe up excess Permatex. Install trunnion bearing (104). Turn axle over and install grease retainer (107) and bearing (105). Lubricate trunnion bearings with lithium base grease according to MIL-G-10924-B.

e. Assemble bearing retainer (93), oil seal (92), bearing (91) and retainer collar (90) on axle shaft (94). Coat the flange of retainer (93) with a thin coating of Permatex No. 2 and position the axle shaft assembly in the housing so that the splines in the shaft engage the splines of the differential. Secure the axle shaft assembly with screws (88) and lock washers (89).

f. Assemble universal-joint (items 83 through 86) and secure to axle wheel (87). Install assembled universal joint and wheel axle to axle shaft (94) and secure with bolts (82).

g. Position spindle support (81) on the axle housing. Align spindle support and bearing bores of the housing. Drive lower trunnion (79) into position without shims. Loosely install bolts (75) and lock washers (76). Allow at least one-fourth inch of play between bolt heads and trunnion. Install lubrication fitting (78).

h. Invert axle assembly. Install shims (72) and upper trunnion (73). Install mounting bracket (70) and secure with screws (68) and lock washers (69).

i. Tighten lower trunnion bolts (75) evenly in small increments until some resistance is felt when the spindle support is pivoted from side to side.

j. Attach a pound pull scale to the tie rod arm on the spindle support. Tighten lower trunnion screws to pre-

load the trunnion bearing until a reading of 46 to 53 pounds is read on the scale. Read scale while spindle support is moving.

k. Use a feeler gage to determine the required shim (80) thickness between the lower flange of the trunnion and the spindle support. Remove the lower trunnion and add the required shims (80). Install the lower trunnion and mounting screws. Recheck preload as in step j. Install puller screws (74).

l. Install lubrication fittings (71), (58), and (59).

m. Press bushing (66) into spindle bore. Edge of bushing must be recessed one-eighth of an inch. Apply light coating of Permatex No. 2, or equivalent to outer diameter of wheel shaft oil seal (67) and press seal (67) into spindle (65). Remove excess sealant. The lip of seal (67) must face toward the spindle bore.

n. Lubricate spindle bushing and lips of seal (67) with light oil. Position spindle support and secure with bolts (63) and lock washers (64).

o. Tap spindle support bushing (62) into place in spindle support. Slide thrust washer (61) on brake camshaft (60). Insert camshaft (60) through bushing (62). Install slack adjuster (57) and retaining washer (56) on the camshaft and secure with retaining ring (55).

p. Position the air chamber on air chamber bracket (70) and secure with nuts (53) and lock washers (54). Secure clevis of brake chamber to slack adjuster with pin (52) and cotter pin (51).

q. Install brake shoes on spindle support and secure with anchor pins (50). Install new brake shoe return springs (45) using a suitable brake pliers. Be sure slack adjusters are adjusted to allow brake shoes to come together as closely as possible to minimize spring tension during installation. Lock brake shoe anchor pins with brake pin set screws (46), washer (49), screw (48) and lock wire (47).

r. Install wheel studs (43) in hub (44). Install bearing cup (41) in hub (44) with wide diameter of taper towards the outside of the hub. Be sure bearing cup (41) is fully seated.

s. Lubricate roller bearing (40) with gear oil and install bearing (40) in hub (44). Press seal (39) into place, and position oil catcher (38).

t. Position brake drum (37) on hub (44), align match marks made during disassembly. Secure with bolts (35) and washers (36).

u. Support the hub and drum assembly with a suitable chain hoist. Lubricate lip of hub and drum seal and position the hub and drum assembly on the axle. Be sure to align the hub and drum assembly with the spindle so that the inner hub bearing does not cock when the assembly is slid onto the spindle.

v. Install bearing cup (34) and bearing (33) in ring gear hub (30). Position internal ring gear (29) on hub (30) and secure with screws (31) and plate retainers

(32). Position the ring gear and hub assembly on the axle so that it engages the splines on the spindle. Drive the assembly into place with a soft mallet.

w. Install inner spindle nut (21) on spindle. Attach heavy cord or string to one of the wheel studs and wrap the cord around the hub several times. Using a pull scale, tighten inner nut (21) until rotating torque measured on the pull scale is between 20 to 26 pounds (27.1—35.3 N · m) for new bearings or 8 to 16 pounds (10.8—21.7 N · m).

x. Install lock nut (20) and outer spindle nut (21). Recheck rotating torque as outlined above. Bend two tangs of lock nut (20) against flats on the inner nut, and two tangs against flats on the outer nut.

y. Coat inside of planetary gears (24) with chassis grease. Install a row of 28 rollers (26), roller spacer (27), and another row of 28 rollers (26) in each pinion gear. Place a thrust washer (25) on each side of planetary gear (24). Position the assemblies in planetary carrier (28). Make sure tangs on the thrust washer engage the grooves in the spider.

z. Press in pinion shafts (22). Be sure that the pinion shaft ball recess aligns with the groove in the spider.

Insert lock ball (23) and press pinion shaft (22) flush with the face of the carrier. Stake shaft ball groove in two places to retain the shaft.

aa. Install packing (16) on the planetary carrier. Install planetary carrier assembly on the hub and secure with bolts (14) and lock washers (15).

ab. Position sun gear (18) and thrust washer (19) on the axle shaft and secure with snap ring (17). Install packing (11) in thrust cap (10) and install cap (10) on the planetary carrier assembly. Secure with screws (8) and washers (9).

ac. Install relief valve (12) and filler plug (13). Install drain plugs (1) and (2).

ad. Press bushing (7) into tie rod end (5). Press only on outer race to prevent damage to the bushing. Install lubrication fitting (6). Install tie rod (5) and secure with bolt (4) and nut (3). Tighten tie rod nut to 300 ft-lb (406.7 N · m).

16-11. Installation

Refer to paragraph 12-8 and install the axle assembly in the carrier. Refer to TM 5-3810-295-12 for lubrication instructions.

Section III. DIFFERENTIAL AND CARRIER ASSEMBLIES

16-12. General

The front and rear carrier differential assemblies are identical except that the rear differential uses a "no spin" unit. The front differential is of the conventional type. Both units are discussed below.

16-13. Removal

a. Refer to paragraph 16-8 and remove the differential as an assembly.

b. Mount the differential assembly on a differential overhaul stand.

16-14. Disassembly

a. Check and record ring gear backlash with a dial indicator. This information will be used during reassembly.

b. Matchmark the bearing caps with a center punch to assure correct match during reassembly.

c. Refer to figure 16-3. Remove screws (1), lock washers (2) and lock nuts (3). Remove screws (4), washers (5) and bearing caps (6).

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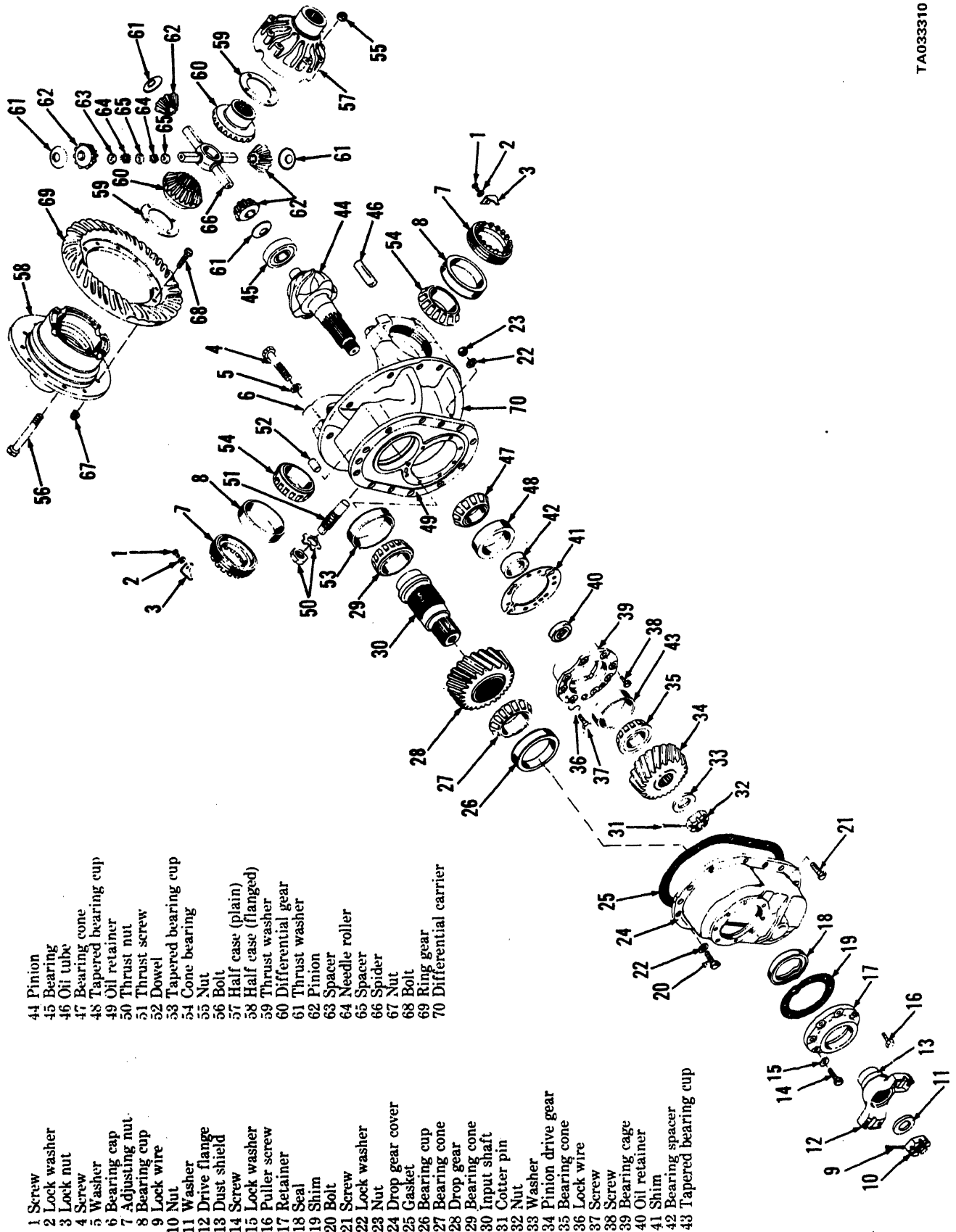


Figure 16-3. Front differential and carrier assembly—exploded view.

d. Insert a metal bar through the differential. Raise the end of the bar and remove adjusting nuts (7) and bearing cups (8). Hoist differential from the carrier assembly.

e. Remove lock wire (9), nut (10), washer (11), and pull drive flange (12) and dust shield (13) from the input shaft. Remove screws (14) and washers (15). Using puller screws (16), remove retainer (17). Drive oil seal (18) from retainer (17). Remove shims (19).

f. Remove bolts (20), screws (21), lock washers (22), and nuts (23). Remove drop gear cover (24) and gasket (25). Press bearing cup (26) from drop gear cover. Remove input shaft as an assembly and remove bearing cone (27), drop gear (28), and bearing cone (29) from input shaft (30).

g. Remove cotter pin (31), shaft nut (32) and washer (33). Using a suitable puller, remove pinion drive gear (34). Remove bearing cone (35).

h. Break lock wire (36) and remove screws (37) and (38). Remove bearing cage (39), oil retainer (40), shim (41), and bearing spacer (42). Press bearing cup (43) from cage (39).

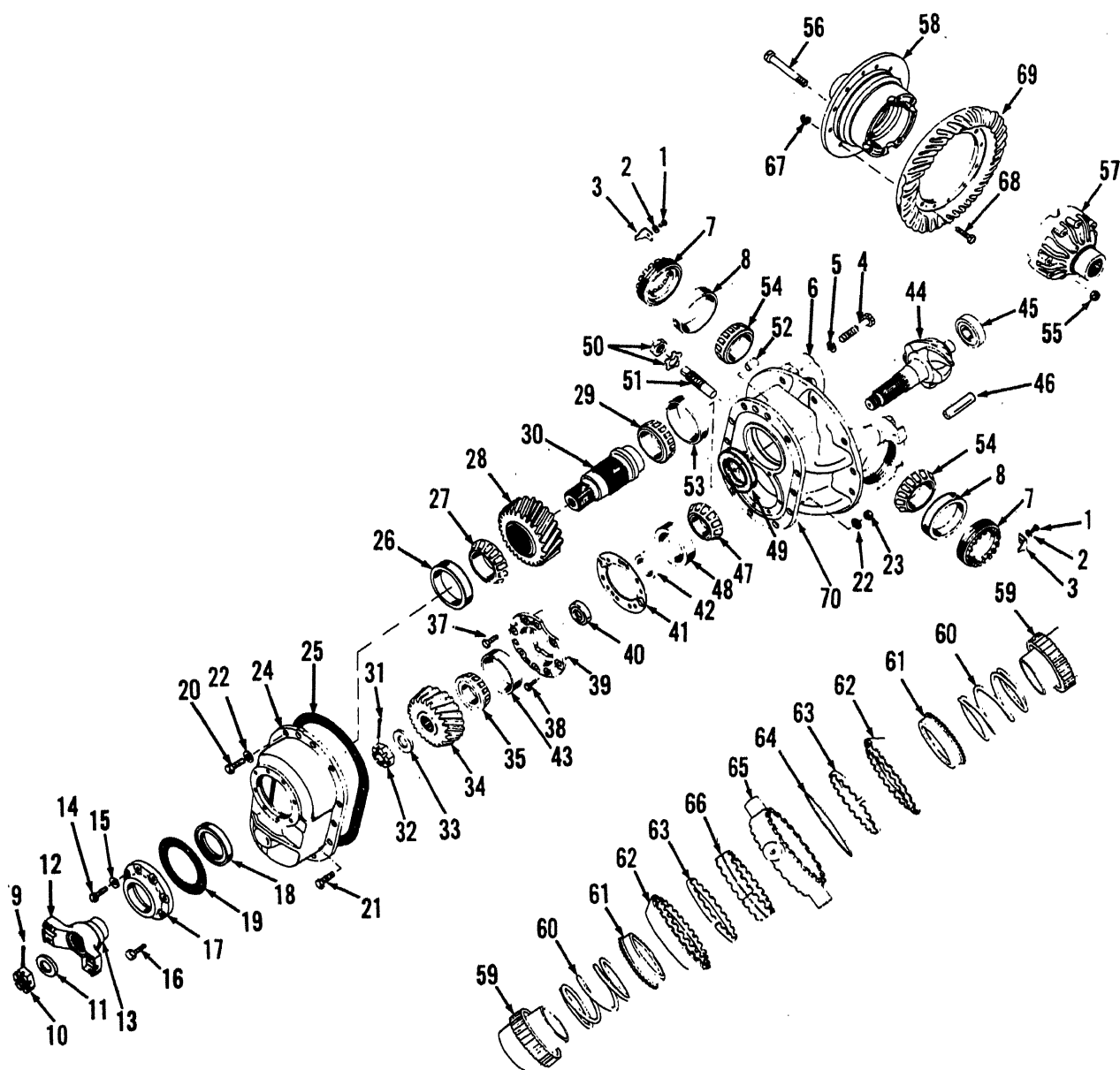
i. Remove pinion (44), bearing (45), and oil tube (46). Remove bearing cone (47), and press bearing cup (48) from carrier. Remove oil retainer (49), thrust nut (50), and thrust screw (51). Remove locating dowel (52). Press bearing cup (53) from carrier housing.

j. Remove bearing (54) from ends of the differential case. Match mark the case halves to assure correct reassembly.

k. Remove nuts (55) and bolts (56). If necessary, use a soft mallet to break the seal between case halves (57) and (58). Lift plain case half (57) from the assembly.

l. Remove thrust washer (59) and differential gear (60). If necessary, remove thrust washers (61) and pinions (62), and remove spacers (63), needle rollers (64) and spacers (65) from spider (66).

m. For rear axle differential refer to figure 16-4. Note that the two units are identical except that the rear axle has a "no spin" differential unit. To disassemble the no spin unit, remove side gear (59), side gear springs (60), and spring and clutch (61). Remove cam and clutch (62), holdout ring (63), and snap ring (64) from spider (65). Remove center cam (66).



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- | | | | |
|-----------------|----------------------|------------------------|-------------------------|
| 1 Screw | 19 Shim | 36 Lock wire | 53 Tapered bearing cup |
| 2 Lock washer | 20 Bolt | 37 Screw | 54 Cone bearing |
| 3 Lock nut | 21 Screw | 38 Screw | 55 Nut |
| 4 Screw | 22 Lock washer | 39 Bearing cage | 56 Bolt |
| 5 Washer | 23 Nut | 40 Oil retainer | 57 Half case (plain) |
| 6 Carrier cap | 24 Drop gear cover | 41 Shim | 58 Half case (flanged) |
| 7 Adjusting nut | 25 Gasket | 42 Bearing spacer | 59 Side gear |
| 8 Bearing cup | 26 Bearing cup | 43 Tapered bearing cup | 60 Side gear spring |
| 9 Lock wire | 27 Bearing cone | 44 Pinion | 61 Spring retainer |
| 10 Screw | 28 Drop gear | 45 Bearing | 62 Cam and clutch |
| 11 Washer | 29 Bearing cone | 46 Oil tube | 63 Holdout ring |
| 12 Drive flange | 30 Input shaft | 47 Bearing cone | 64 Snap ring |
| 13 Dust shield | 31 Cotter pin | 48 Tapered bearing cup | 65 Spider |
| 14 Screw | 32 Nut | 49 Oil retainer | 66 Center cam |
| 15 Lock washer | 33 Washer | 50 Thrust nut | 67 Nut |
| 16 Puller screw | 34 Pinion drive gear | 51 Thrust screw | 68 Bolt |
| 17 Retainer | 35 Bearing cone | 52 Dowel | 69 Ring gear |
| 18 Seal | | | 70 Differential carrier |

Figure 16-4. Rear differential and carrier assembly—exploded view.

n. To remove ring gear (69), remove nuts (67) and bolts (68).

16-15. Cleaning, Inspection and Repair

a. Clean all parts in cleaning solvent, Federal Specification P-D-680, or equivalent, before inspection.

b. Replace all seals and packing.

c. Inspect all rollers, cages and cups for wear, chipping and nicks. Do not replace a bearing cone or cup without replacing the mating cup or cone. After inspection, dip bearings in light oil. Wrap bearings in clean, lintless cloth or paper.

d. If possible, check all gears and shafts using the magnaflux process. Examine teeth and ground and polished surfaces for wear, pitting, chipping, nicks, cracks and scores. Replace all gears having cracked or chipped teeth. Small nicks may be removed with a suitable hone.

e. Check differential pinions and side gears for signs of wear, chipping, cracks, and pitting. Differential pinions and side gears must be replaced as a set. Differential ring gear and pinion must also be replaced as a set if either is damaged.

f. Inspect carrier for cracks or conditions that could cause subsequent oil leaks or failures. Check bearing bores and seal seating surfaces for nick and burrs.

16-16. Reassembly

a. Refer to figure 16-3. Press inner pinion bearing (45) on pinion (44). Stake pinion shaft in four places to retain the bearing, using a square end staking tool.

b. Press center pinion bearing cone (47) onto pinion shaft (44). Install spacer (42) and shim (40) on shaft (44). Press bearing cups (43) and (48) into pinion bearing cage (39).

c. Position pinion bearing cage assembly on pinion shaft (44). Position outer bearing cone (35) on the shaft and press into place in bearing cup (43).

d. Hold pinion cage assembly in a press, pinion end down, with approximately 500 pounds pressure on the bearing drive. Wrap several turns of soft wire or cord around the pinion cage. Pull the cord in a straight line with a spring scale. Read the scale while the cage rotates. Multiply scale reading by one-half the diameter of the bearing cage. Preload torque should be between 13 and 23 in-lb (1.5—2.6 N · m). If preload is not correct, add shims to increase preload. Remove shims to decrease preload.

NOTE

This is only a preliminary preload check.

e. Press bearing cones (54) onto case half (58) and case half (57). Check ring gear mounting surface of flanged case half (54) for burr. Burrs may be removed with a file.

f. Install ring gear (69) on flanged case half (58). Secure with bolts (68) and nuts (67).

g. Lubricate and install thrust washer (59) and

differential side gear (60) in case half (58). Engage holes in thrust washer on dowels projecting from thrust washer bearing surface.

h. Apply coating of grease to spider (66) so that needle rollers (64) can be assembled. Each spider leg should carry a double row of rollers (64), separated by spacer (65) between rows and at the bottom of the leg. Spacer (63) is installed on the end of the spider leg. Slide pinion (62) into position and install thrust washer (61) on the outside of pinion (62).

i. Place the assembled pinion and spider in position on the installed side gear. It is important that the tangs of the pinion thrust washers (61) engage their respective grooves in the core halves.

j. Install remaining thrust washer (59) and side gear (60) in case half (57). Place the assembly on case half (58), making sure all thrust washers are properly seated and gear teeth are properly meshed. Be sure matchmarks on the case halves are aligned. Install bolts (56) and nuts (55). Install oil tube (46) and dowel (52) in carrier (70). Press bearing cup (53) and oil retainer (49) in carrier.

k. For rear axle differential, omit paragraphs g through j above. Refer to figure 6-4 and assemble "no spin" differential, items (59) through (65). Install the assembly in the ring gear case half assemble case half (58) on the unit. Be sure match marks on case halves are aligned. Install bolts (56) and nuts (55). Install oil tube (46) and dowel (52) in carrier (70). Press bearing cup (53) and oil retainer (49) in carrier (70).

l. Install assembled bearing cage and pinion shaft in the carrier assembly. Do not install bearing cage shims. Use four pinion oil seal retainer bolts with flat washers to pull pinion shaft assembly fully into the carrier. Be sure oil passages are aligned. Install three flat washers on each bolt to prevent bottoming.

m. Use an inch-pound torque wrench to check bearing preload at the pinion shaft. Preload should be between 13 and 23 in-lb (1.5—2.6 N · m). Add or remove shims (41) to attain proper preload. When proper preload is attained, remove temporary bolts used to hold bearing cage to housing. Install oil seal (40).

n. Install screws (37) and (38) and lock wire (36) the screws in position. Install pinion drive gear (34), washer (33) and nut (32). Tighten nut (32). Install cotter pin (31).

o. Position the carrier and pinion shaft assembly in the differential stand so that the pinion shaft is down. Insert a steel bar through the differential case halves to facilitate handling. Position the differential into the carrier. Position differential bearing cups (8) and adjusting nuts (7), one set at a time by lifting the alternate sides of the steel bar.

NOTE

If bearing cones (54) were replaced, new bearing cups (8) should also be replaced.

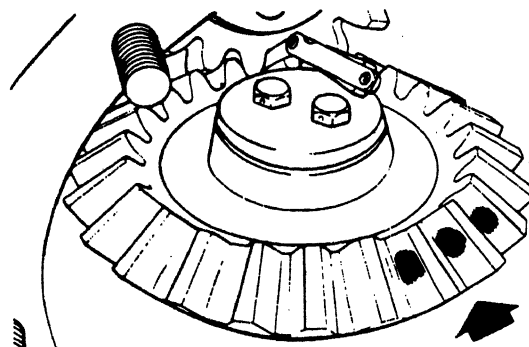
p. Position bearing caps (6) on bearings, making sure matchmarks made during disassembly are properly aligned. Install bearing cap bolts (4) and washers (5) and tighten until snug. Do not fully torque.

q. Tighten adjusting nuts (7) to adjust bearings to zero end play. All bearing rollers must rotate as the ring gear rotates, but it should not be possible to move bearing rollers sideways in the cage when prying against them with screwdriver.

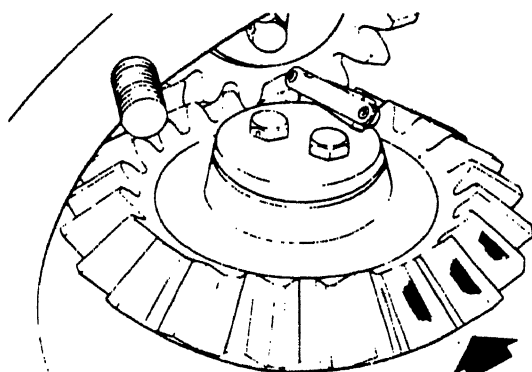
r. Use a dial indicator to check backlash between the ring gear and pinion shaft gear. Adjust backlash by moving the ring gear toward or away from the pinion shaft gear. Move the ring gear by loosening one adjusting nut (7) and tightening the other. Be careful to match the movement of the adjusting nuts to preserve

the bearing adjustment made in previous assembly steps. If original ring gear and pinion set are used, adjust backlash to that noted at disassembly.

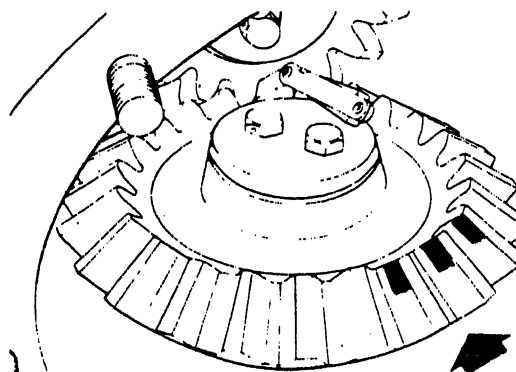
s. Check ring gear and pinion gear for proper tooth contact, as shown in figure 16-5. Paint ring gear teeth with a mixture of red lead and linseed oil. When ring and pinion gears are rotated, the red lead is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape and location of the contacts. Gears should be rotated, under slight load, until ring gear has turned at least one revolution in both directions. Check tooth contact pattern on drive side of ring gear teeth. Coast side will automatically be correct when drive side pattern is correct.



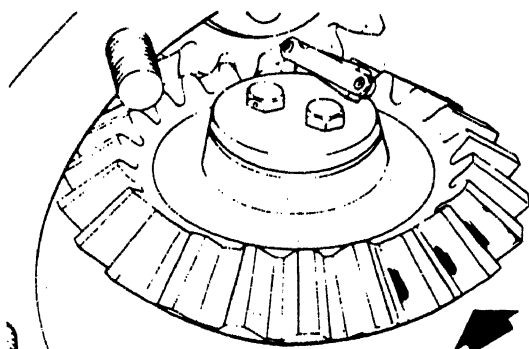
1. GOOD TOOTH CONTACT.



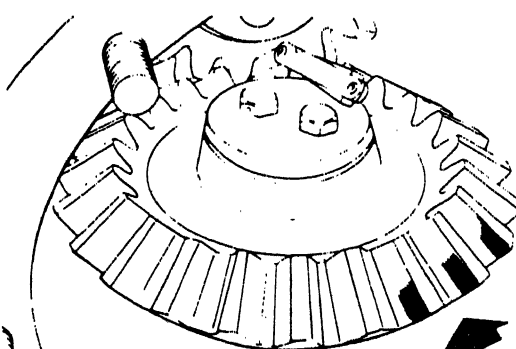
2. POOR - CAUSES TOOTH GALLING AND NOISY OPERATION. MOVE PINION TOWARD GEAR FOR CORRECT CONTACT AND LOWER GEAR FOR CORRECT BACKLASH.



3. POOR - CAUSES TOOTH GROOVING, GALLING AND NOISY OPERATION. MOVE PINION AWAY FROM GEAR FOR CORRECT CONTACT AND RAISE GEAR FOR CORRECT BACKLASH.



4. POOR - CAUSES CHIPPING AND EXCESSIVE WEAR. LOWER GEAR FOR CORRECT CONTACT, MOVE PINION TOWARD GEAR FOR CORRECT BACKLASH.



5. POOR - CAUSES CHIPPING AND EXCESSIVE WEAR. RAISE GEAR FOR CORRECT CONTACT, MOVE PINION AWAY FROM GEAR FOR CORRECT BACKLASH.

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Figure 16-5. Differential gear contact chart.

t. If tooth contact pattern is not proper, readjust backlash, or add or remove pinion bearing cage shims as necessary.

u. Tighten bearing cap bolts (4). Using a dial indicator, recheck ring gear and pinion backlash. Recheck differential bearing end play.

v. Using a dial indicator, check the back face of the ring gear. Rotate the ring gear at least one full revolution. Runout must not exceed 0.005 inch total indicator reading. If runout is excessive, remove assembly and check for burrs or dirt under the mounting surface of the ring gear.

w. Install adjusting lock nuts (3), lock washers (2) and screws (1). Apply light coating of Permatex No. 2, or equivalent, to thrust screw (51). Turn screw in until it just contacts the back of the ring gear. Then back off one-quarter turn (0.010 clearance). Tighten lock nut (50).

x. Press bearing cone (29) onto input shaft (30). In-

stall drop gear (28) on the input shaft. Press bearing cup (26) into drop gear cover (24). Press seal (18) into cover (24). Install bearing (27) on shaft (30). Install input shaft assembly in carrier (70).

y. Install gasket (25) and drop gear cover (24) on the differential carrier. Secure with screws (20) and (21), washers (22), and nuts (23). Install shim (19) and retainer (17). Secure with screws (14) and (16) and washers (15).

z. Install drive flange (12) and secure with screw (10) and washer (11). Install lock wire (9).

16-17. Installation

a. Refer to paragraph 16-11 and install the differential.

b. Before installing the rear axle in the carrier, check operation of the "no spin" differential. Rotate both wheels forward. Rotate one wheel and hold the other, alternately. Perform this test while rotating the wheels in the reverse direction.

Section IV. BRAKE ASSEMBLY

16-18. General

Brake repair here is included as part of the axle repair procedure. It is not necessary, under normal circumstances, to disassemble the entire axle assembly to change brake linings.

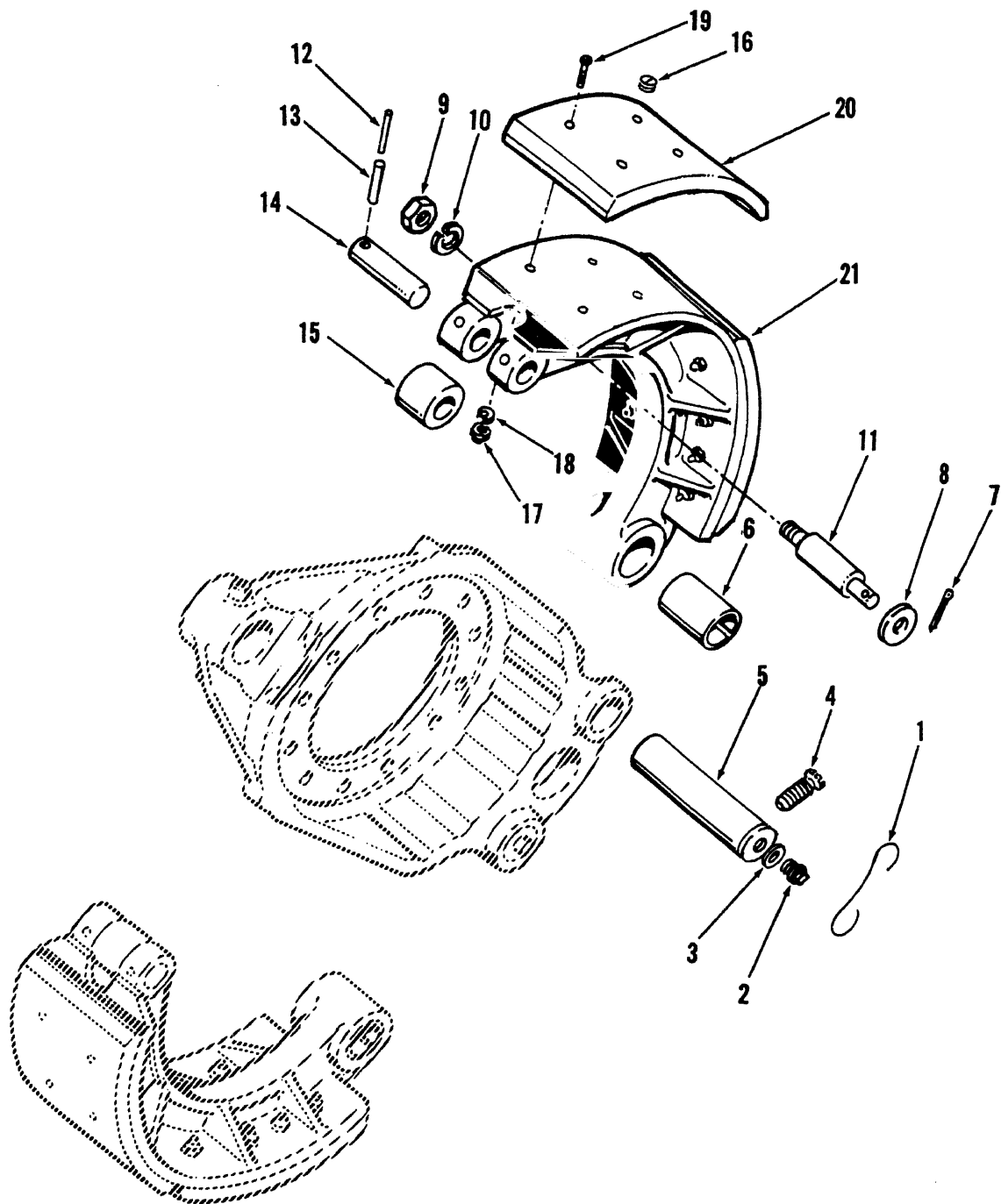
16-19. Removal

Refer to chapter 16, sections I and II. Remove wheel

and tire assembly and disassemble axle assembly through *k*, paragraph 16-8.

16-20. Disassembly

a. Refer to figure 16-6. Items 1 through 5 are removed during removal procedures.



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- 1 Lock wire
- 2 Screw
- 3 Lock washer
- 4 Anchor screw
- 5 Anchor pin
- 6 Bushing
- 7 Cotter pin

- 8 Washer
- 9 Nut
- 10 Lock washer
- 11 Spring pin
- 12 Roll pin
- 13 Roll pin
- 14 Roller pin

- 15 Cam roller
- 16 Lining plug
- 17 Nut
- 18 Washer
- 19 Bolt
- 20 Brake lining
- 21 Brake shoe

Figure 16-6. Brake shoe assembly—exploded view.

b. Press brake shoe bushing (6) from brake shoe. If inside diameter of bushing (6) exceeds 1.513 inch, the bushing should be replaced.

c. Remove cotter pin (7), washer (8), nut (9), washer (10) and spring pin (11).

d. Using a suitable punch, drive out roll pins (12) and (13), and roller pin (14). Remove cam roller (15).

e. Remove brake shoe linings by removing plugs (16), nuts (17), washers (18), and bolts (19). Remove lining (20) from shoe (21).

16-21. Cleaning, Inspection and Repair

a. Clean all metal parts in cleaning solvent, Federal Specification P-D-680, or equivalent before inspecting.

b. Check brake lining for oil or grease saturation

and wear. Replace lining if saturated with grease or oil. If linings are worn to within one-sixteenth of an inch of bolt heads, replace linings.

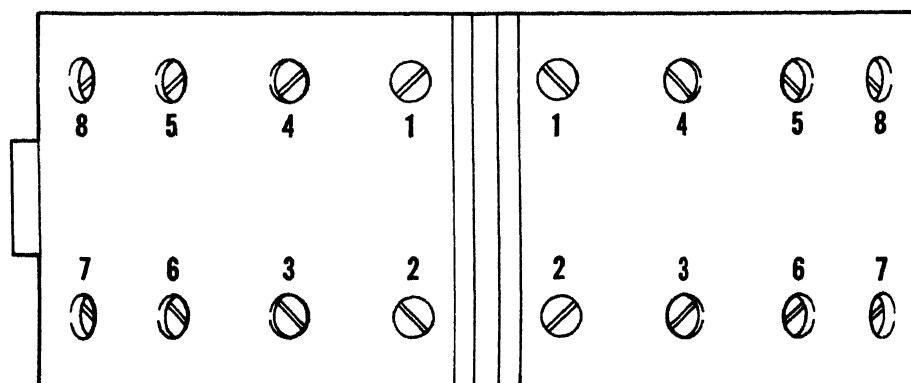
NOTE

When replacing brake linings, replace all linings on both sides of the axle.

c. Check bushing (6). If inside diameter exceeds 1.513 inch, replace the bushing.

16-22. Reassembly

a. Install brake linings (20) on shoe (21) and secure with bolts (19), washers (18) and nuts (17). Tighten nuts to 16—18 ft-lb (21.7—24.4 N • m), in the sequence shown in figure 16-7. Install linings plugs (16).



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Figure 16-7. Brake lining installation.

b. Position brake cam roller (15) on brake shoe. Apply a light coating of lithium base grease (wheel bearing grease) on roller pin (14) and insert pin. Secure with roll pins (12) and (13).

c. Press brake shoe bushings (6) into the brake shoe.

d. Install spring pin (11) in brake shoe and secure

with washer (10) and nut (9). Install washer (8) and cotter pin (7).

16-23. Installation

Refer to figures 16-5 and 16-2 and install brake shoe assembly. Refer to chapter 16, sections I and II, and assemble axle parts and install wheel and tire assembly.

CHAPTER 17

REPAIR OF CARRIER STEERING SYSTEM

Section I. REPAIR OF STEERING WHEEL, COLUMN AND GEAR BOX

17-1. Description

The carrier is equipped with a mechanical steering system with hydraulic power assist. The carrier steering system incorporates three methods of steering; (1) two-wheel steering, (2) four-wheel steering and (3) crab steering. The operator selects the steering method most desirable, for specific operating conditions, with a selector valve in the carrier cab. In two-wheel steer, the rear wheels are locked in the center position by a locking pin, and steering is accomplished with front wheels only. In four-wheel and crab steer both front and rear wheels are utilized in steering. In four-wheel steer, the rear wheels rotate opposite of the front wheels to reduce the turning radius. In crab steer the rear wheels turn in the same direction as the front wheels, allowing the vehicle to move in a crab-like fashion.

17-2. Removal and Disassembly

a. Refer to figure 17-1 and remove components as described in the following steps.

(1) Remove horn button assembly. (TM 5-3810-295-12)

(2) Remove nut (1) and using a suitable puller remove steering wheel (2).

(3) Remove turn signal switch. (TM 5-3810-295-12)

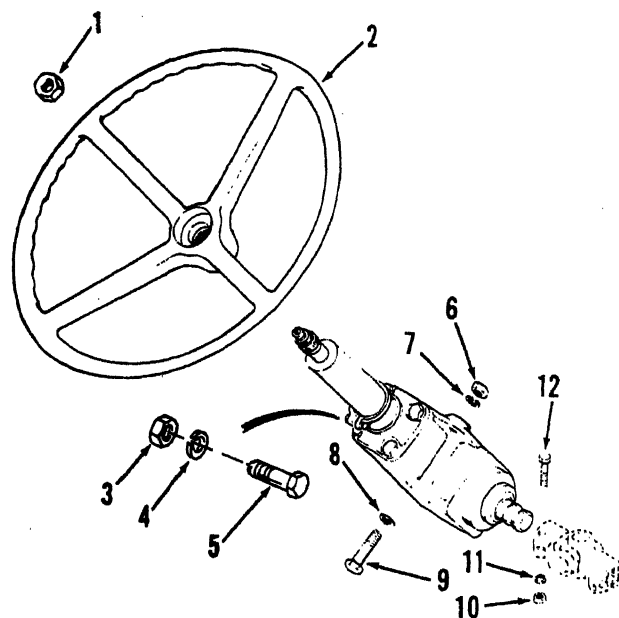
(4) Remove trailer brake control valve. (TM 5-3810-295-12)

(5) Remove nut (3), lock washer (4) and cap screw (5).

(6) Remove nuts (6), lock washers (7), flat washers (8), and cap screws (9).

(7) Remove nut (10), lock washer (11) and cap screw (12).

Lift steering column and gear box assembly from panel.



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- 1 Nut
- 2 Wheel
- 3 Nut
- 4 Lock washer
- 5 Cap screw
- 6 Nut
- 7 Lock washer
- 8 Flat washer
- 9 Cap screw
- 10 Nut
- 11 Lock washer
- 12 Cap screw

Figure 17-1. Steering wheel, column, and gear box removal.

b. Refer to figure 17-2 and disassemble steering column and gear box as follows:

(1) Remove cap screws (1) and lock washers (2). Remove cover (3) from housing (42).

(2) Remove oil seal (4) and pipe plug (5) from cover (3). Discard oil seal.

(3) Remove shims (6), (7) and (8). Remove shaft assembly from housing (42).

(4) Remove cap screw (9), washer (10), bevel gear (11), collar (12), bearing (13), spacer (14), shim (15), spacer (16), and bearing (17) from shaft (18).

(5) Remove cap screws (19) and washers (20). Lift

cover (21) off housing (42). Remove bearing (22), spring (23) and seat (24) from tube (25).

(6) Remove tube (25) from shaft (40).

(7) Remove screw (26) and contact ring (27) from shaft (40).

(8) Remove cap screw (28), washer (29), bevel gear (30), collar (31), bearing (32), spacer (33), shim (34), spacer (35) and bearing (36) from shaft (40).

(9) Remove shims (37), (38) and (39) from cover (21).

(10) Remove pipe plug (41) from housing (42).

- | | |
|-----------------|-------------------|
| 1 Cap screw | 23 Bearing spring |
| 2 Lock washer | 24 Spring seat |
| 3 Cover | 25 Tube |
| 4 Oil seal | 26 Screw |
| 5 Pipe plug | 27 Contact ring |
| 6 Shim (0.010") | 28 Cap screw |
| 7 Shim (0.003") | 29 Washer |
| 8 Shim (0.002") | 30 Bevel gear |
| 9 Cap screw | 31 Collar |
| 0 Washer | 32 Bearing |
| 1 Bevel gear | 33 Spacer |
| 12 Collar | 34 Shim |
| 13 Bearing | 35 Spacer |
| 14 Spacer | 36 Bearing |
| 15 Shim | 37 Shim |
| 16 Spacer | 38 Shim |
| 17 Bearing | 39 Shim |
| 18 Shaft | 40 Shaft |
| 19 Cap screw | 41 Pipe plug |
| 20 Lock washer | 42 Housing |
| 21 Cover | |
| 22 Bearing | |

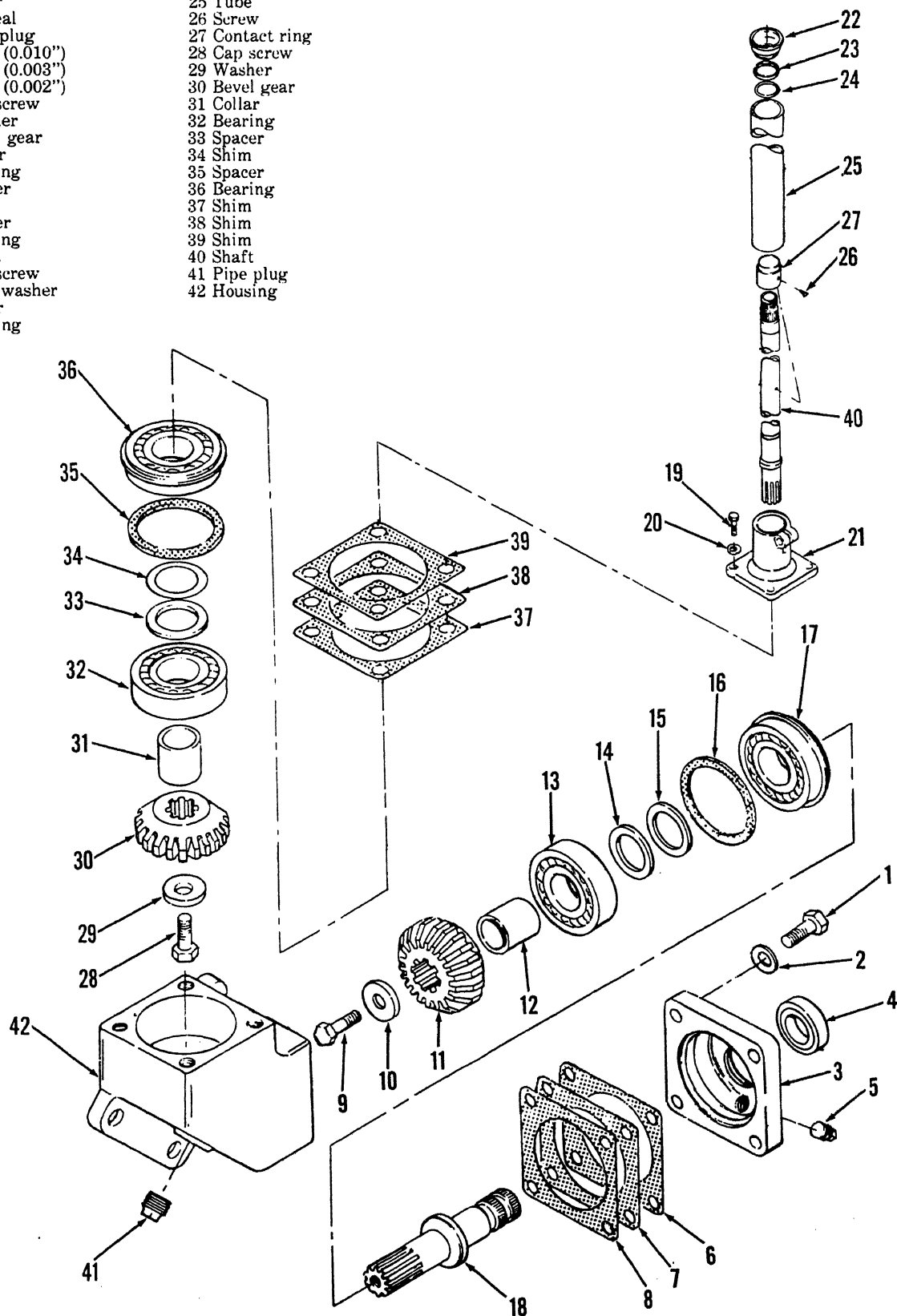


Figure 17-2. Steering column and gear box—exploded view.

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17-3. Cleaning, Inspection and Repair

a. Clean all metal parts in cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry with compressed air.

b. Inspect all parts for cracks, breaks or other damage. Replace damaged or defective parts.

c. Check all bearings and bearing surfaces in housings and covers for wear or damage. Replace worn or damaged parts.

d. Replace all oil seals.

17-4. Reassembly and Installation

a. Refer to figure 17-2 and reassemble gear box and steering column as follows:

(1) Assemble pipe plug (41) into housing (42).

(2) Assemble bearing (36), spacer (35), shim (34) spacer (33), bearing (32), collar (31) and bevel gear (30). Secure in place with washer (29) and cap screw (28). Install cap screw (28), with Lock Tite sealer or equivalent, and tighten to 70—75 ft-lb (94.9—101.7 N • m) torque.

NOTE

Preload of bearings (32) and (36) must be adjusted to 2.0—8.0 in (.23—.90 N • m) torque.

(3) Press bearing and shaft assembly into housing (42) being careful not to score bearings or bearing surfaces in the housing.

(4) Place proper shims (37), (38) and (39) on housing (42). Slide cover (21) over shaft (40) and secure to housing (42) with lock washer (20) and cap screw (19).

(5) Assemble contact ring (27) to shaft (40) and secure in place with screw (26).

(6) Slide tube (25) over shaft (40) and install spring seat (24) and spring (23). Press bearing (22) into tube (25).

(7) Place bearing (17), spacer (16), shim (15), spacer (14), bearing (13), collar (12), and bevel gear (11) on shaft (18). Secure with lock washer (10) and cap

screw (9). Install cap screw (28), with lock tite sealer, or equivalent, tighten to 70—75 ft-lb (94.9—101.9 N • m) torque.

NOTE

Preload of bearings (13) and (17) shall be adjusted to 2.0—8.0 in-lb (.23—.90 N • m).

(8) Press bearings and shaft assembly into housing (42) being careful not to score the bearings or bearing surface in the housing.

(9) Place proper shims (6), (7) and (8) on housing (42).

(10) Install pipe plug (5) in cover (3). Press new oil seal (4) into cover.

(11) Install cover (3), over shaft, onto housing (42). Secure with lock washers (2) and cap screw (1).

b. Refer to figure 17-1 and install the steering column and gear box as follows:

(1) Place steering column and gear box assembly in position.

(2) Install capscrews (9), flat washers (8), lock washers (7) and nuts (6). Snug tighten only.

(3) Install cap screw (12), lock washer (11) and nut (10). Snug tighten only.

(4) Install cap screw (5), lock washer (4) and nut (3). Insure assembly is properly aligned and tighten all attaching hardware.

(5) Install trailer control valve (TM 5-3810-295-12).

(6) Install turn signal switch (TM 5-3810-295-12).

(7) Install steering wheel (2) over splined shaft and secure with nut (1).

NOTE

Steering wheel should be installed in straight-ahead position with steering gear centered.

(8) Install horn button assembly (TM 5-3810-295-12).

Section II. REPAIR OF STEERING SHAFTS AND STUB SHAFT GEAR BOX

17-5. Description

The steering shafts and stub gear box permits removal of the worm gear assembly or steering shaft and column independent of each other.

17-6. Removal and Disassembly

a. Refer to figure 17-3 and remove steering shafts and stub shaft gear box as follows.

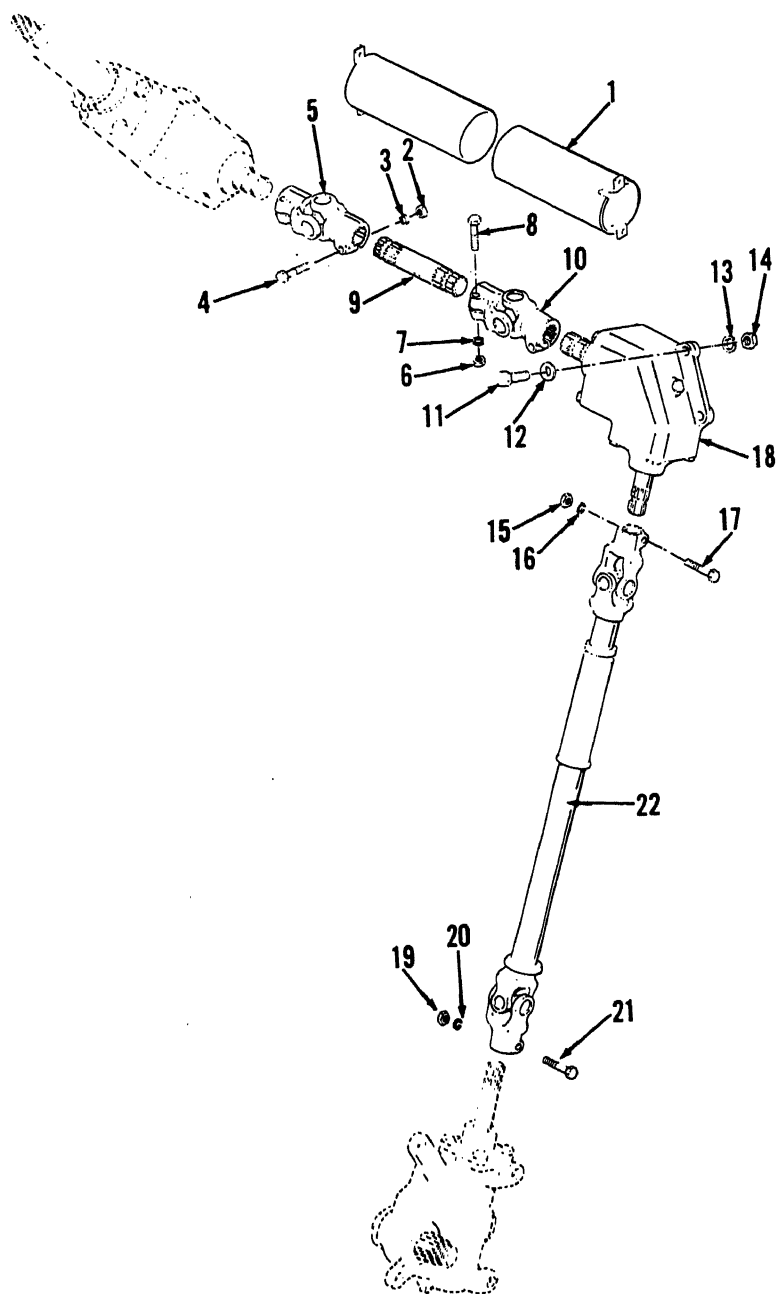
(1) Remove shaft guard (1). Remove nut (2), lock washer (3) and cap screw (4).

(2) Slide universal joint (5) off shaft (9). Remove nut (6), lock washer (7) and cap screw (8). Remove shaft (9) and universal joint (10).

(3) Remove cap screw (11), washer (12), lock washer (13) and nut (14).

(4) Remove nut (15), lock washer (16) and cap screw (17). Remove stub shaft gear box (18).

(5) Remove nut (19), lock washer (20) and cap screw (21). Slide shaft and universal assembly (22) from vehicle.



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- | | |
|--------------------|------------------------------|
| 1 Shaft guard | 12 Flat washer |
| 2 Nut | 13 Lock washer |
| 3 Lock washer | 14 Nut |
| 4 Cap screw | 15 Nut |
| 5 Universal joint | 16 Lock washer |
| 6 Nut | 17 Cap screw |
| 7 Washer | 18 Gear box |
| 8 Cap screw | 19 Nut |
| 9 Shaft | 20 Lock washer |
| 10 Universal joint | 21 Cap screw |
| 11 Cap screw | 22 Shaft and universal joint |

Figure 17-3. Steering shafts and stub shaft gear box—exploded view.

b. Refer to figure 17-4 and disassemble stub shaft gear box as described.

(1) Remove cap screws (1) and lock washers (2). Remove cover (3) from housing (37).

(2) Remove oil seal (4) and pipe plug (5) from cover (3). Discard oil seal.

(3) Remove shaft and gear assembly from housing

(37).

(4) Remove lock screw (6), washer (7), bevel gear (8), bearing (9), spacer (10), shim (11), spacer (12), bearing (13), and collar (14) from shaft (15).

(5) Remove shims (16), (17) and (18) from housing (37).

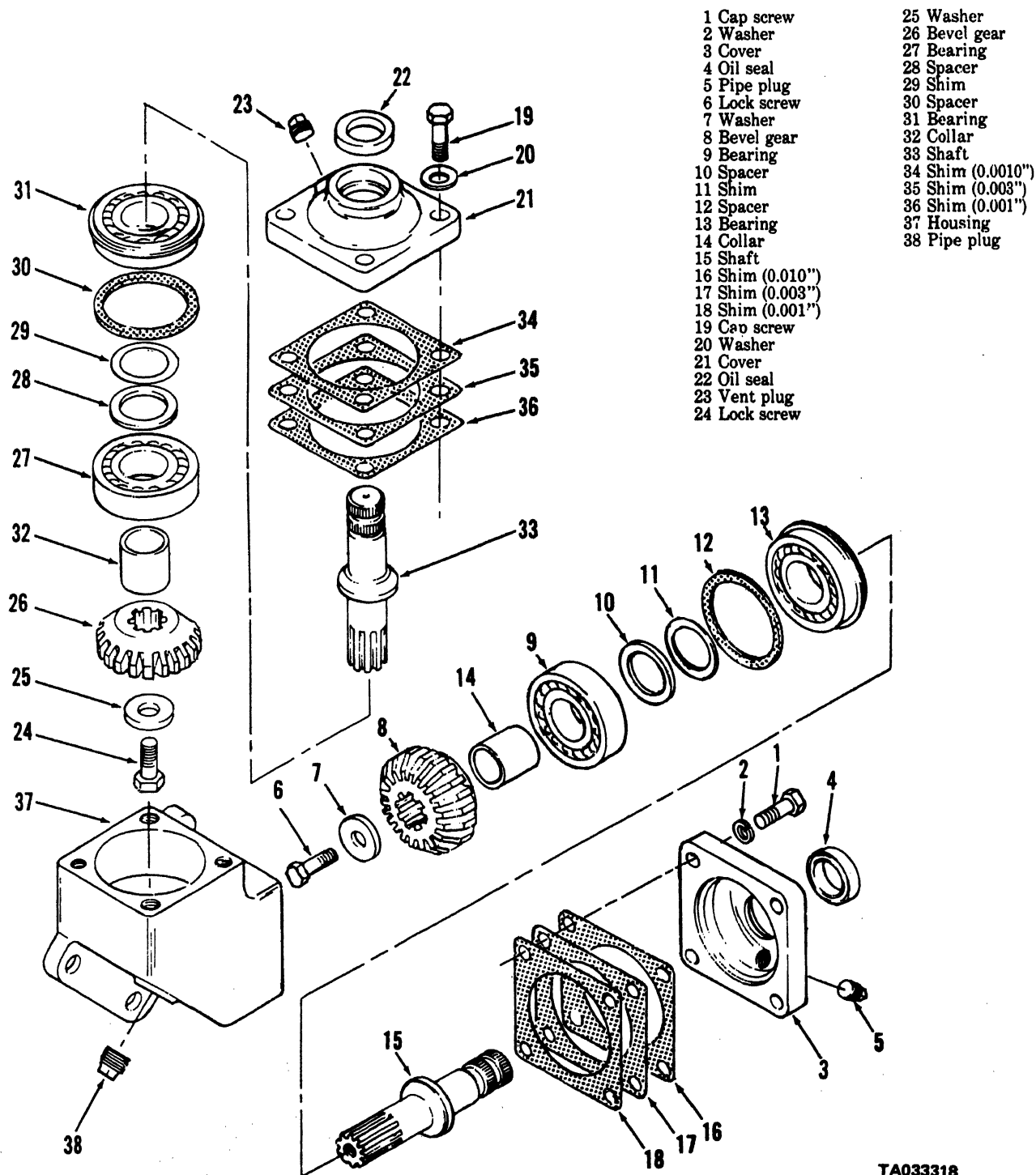


Figure 17-4. Stub shaft gear box—exploded view.

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(6) Remove cap screws (19) and lock washers (20). Lift cover (21) off housing (37).

(7) Remove oil seal (22) and vent plug (23) from cover (21).

(8) Remove lock screw (24), washer (25), bevel gear (26), bearing (27), spacer (28), shim (29), spacer (30), bearing (31), and collar (32) from shaft (33).

(9) Remove shims (34), (35) and (36) from housing (37).

(10) Remove pipe plug (38) from housing (37).

17-7. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly with compressed air.

b. Inspect all parts for cracks, breaks or other damage. Replace as necessary any damaged or defective parts.

c. Replace all oil seals.

d. Check all bearings and bearing surfaces in covers and housings, for wear or damage. Replace all excessively worn or damaged parts.

17-8. Reassembly and Installation

a. Refer to figure 17-4 and reassemble the stub shaft gear box as follows:

(1) Assemble pipe plug (38) into housing (37).

(2) Assemble collar (32), bearing (31), spacer (30), shim (29), spacer (28), bearing (27) and bevel gear (26) to shaft (33). Secure in place with washer (25) and lock screw (24). Install lock screw (24) with Lock Tite sealer or equivalent, and tighten to 70—75 ft-lb (94.9—101.7 N • m) torque.

NOTE

Preload of bearings (27) and (31) must be adjusted to 2.0—8.0 in-lb (.23—.90 N • m) torque.

(3) Press bearing and shaft assembly into housing (37). Care must be taken not to score bearings or bearing surfaces.

(4) Place proper shims (34), (35) and (36) on housing (37).

(5) Assemble vent plug (23) and new oil seal (22) to cover (21) and install cover (21) on housing (37). Secure with lock washer (20) and cap screw (19).

(6) Assemble collar (14), bearing (13), spacer (12), shim (11), spacer (10), bearing (9) and bevel gear (8) to shaft (15). Secure with washer (7) and lock screw (6).

(7) Install lock screw (6) with Lock Tite sealer, or equivalent. Tighten to 70—75 ft-lb (94.9—101.7 N • m).

NOTE

Preload of bearings (9) and (13) shall be adjusted to 2.0—8.0 in-lb (.23—.90 N • m) torque.

(8) Press bearing and shaft assembly into housing (37). Care must be taken not to score the bearings or bearing surfaces in the housing.

(9) Place proper shims (16), (17) and (18) on housing (37).

(10) Assemble new oil seal (4) and pipe plug (5) to cover (3).

(11) Install cover (3), over shaft on housing (37). Secure with lock washers (2) and cap screws (1).

b. Refer to figure 17-3 and install the stub shaft gear box and steering shafts as follows.

(1) Install shaft and universal assembly (22) to the worm gear assembly.

(2) Install cap screw (21), lock washer (20) and nut (19). Snug tighten.

(3) Set stub shaft gear box (18) on universal shaft (22) and install cap screw (17), lock washer (16) and nut (15). Snug tighten.

(4) Install nuts (14), lock washers (13), washers (12) and cap screws (11). Snug tighten.

(5) Place universal joint (10) and shaft (9) on gear box (18). Install cap screws (8), lock washers (7) and nuts (6). Snug tighten only.

(6) Install universal joint (5) on shaft (9) and secure with cap screw (4), lock washers (3) and nuts (2).

(7) Align all steering shaft and gear box to the proper position and torque all attaching hardware.

(8) Install guard (1).

Section III. REPAIR OF STEERING GEAR BOX AND POWER STEERING CONTROL VALVE

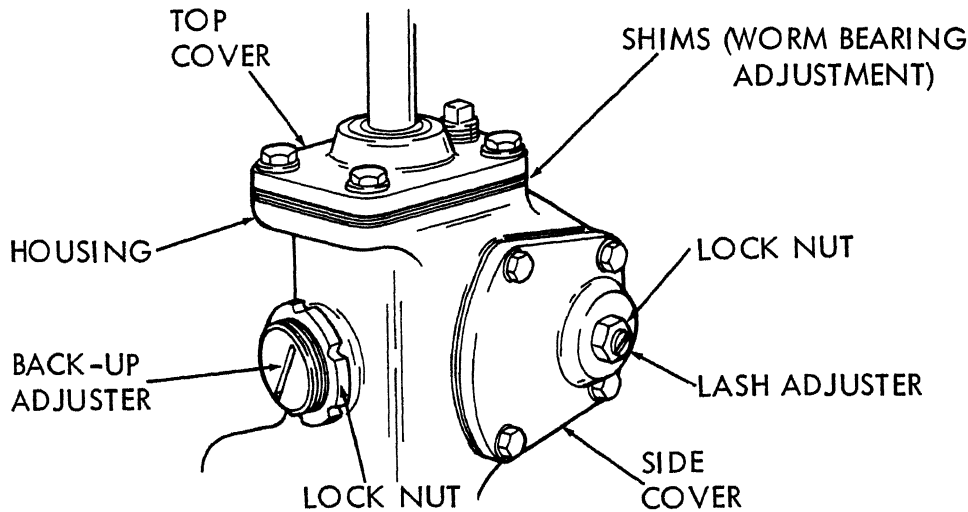
17-9. Description

The manual steering gear is the recirculating-ball-nut type. The mechanical element of this steering gear is a low-friction, high-efficiency recirculating ball system in which steel balls act as a rolling thread between the steering worm and ball nut. The rack of the ball-nut meshes with the sector of the pitman shaft. The ball nut, mounted on the worm, is driven through steel balls which circulate in helical grooves between the worm and nut. Ball return guides, attached to the nut, serve to recirculate the two sets of balls.

The teeth on the sector of the pitman shaft, and the ball nut are so designed that a tighter fit exists between the two when the front wheels are straight ahead. Preload adjustment between the pitman shaft sector gear and the rack teeth of the ball nut is maintained by a preload adjuster screw threaded through the side cover, which moves the pitman shaft endwise. The worm bearing adjuster plug is threaded and provided with a lock nut to provide proper preloading of the worm between the upper and lower worm thrust bearings.

17-10. Steering Gear Adjustments

The steering gear assembly is designed to provide adjustment to compensate for normal wear at worm bearings, pitman shaft, and mating parts. See figure 17-5 for adjustment points.



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Figure 17-5. Steering gear and adjustment points.

NOTE

Worm gear preload adjustment must be checked and adjusted if necessary before making pitman preload adjustment.

a. Disconnect drag link from pitman arm. Relative positions of linkage and pitman arm shall be noted as parts must be reassembled in the same relative position.

b. Proper adjustment of worm bearings is obtained by adding or removing shims between steering gear housing and top cover or end cover (fig. 17-5). Shims are available in thickness of 0.002 inch, 0.005 inch, and 0.030 inch.

(1) When steering gear box has been assembled per paragraph 17-13a, loosen lash adjuster lock nut (fig. 17-5) and turn lash adjuster a few turns counterclockwise to relieve the load from the worm bearing and to provide clearance between the sector gear (10, fig. 17-7) and the worm ball nut (29).

(2) Carefully rotate the worm shaft (21) all the way to one stop and then back off one full turn. With a 12-point socket on splined end of shaft and an inch-pound torque wrench, measure amount of torque required to maintain shaft movement. Torque reading shall be 14—18 in-lb (1.58—2.03 N · m). If torque does not meet this requirement, add or remove shims as required.

c. Adjust the pitman shaft lash as described in the following:

(1) Count the number of turns required to rotate the worm gear from one stop to the other. Starting at one stop rotate worm gear, exactly one-half the total revolutions, to the center position. Mark the input shaft and the housing, establishing a center position reference point.

(2) Turn the last adjuster screw clockwise to remove all backlash between gear teeth. Tighten adjuster screw lock nut to 25—35 ft-lb (33.9—48 N · m) torque.

(3) Using a 12-point socket and an inch-pound torque wrench measure the highest torque required to move the input shaft through the center position. Torque must be 8—12 in-lb (.90—1.4 N · m) in excess of the worm bearing preload, but not to exceed 30 in-lb (3.39 N · m).

(4) If above requirements are not met repeat (2) and (3) above until torque reading is within specification. Always recheck torque reading of input shaft after lock nut has been tightened.

(5) Loosen lock nut on back-up adjuster (fig. 17-5), turn adjuster in until it bottoms, then back it out one-eighth to one-fourth turn and tighten lock nut.

d. After all adjustments have been made install steering box in the vehicle frame. Install the pitman arm on the pitman shaft (10, fig. 17-7) aligning it with the reference marks established at time of disassembly.

17-11. Removal and Disassembly

a. Refer to figure 17-6 and remove steering gear box and power steering control valve as follows:

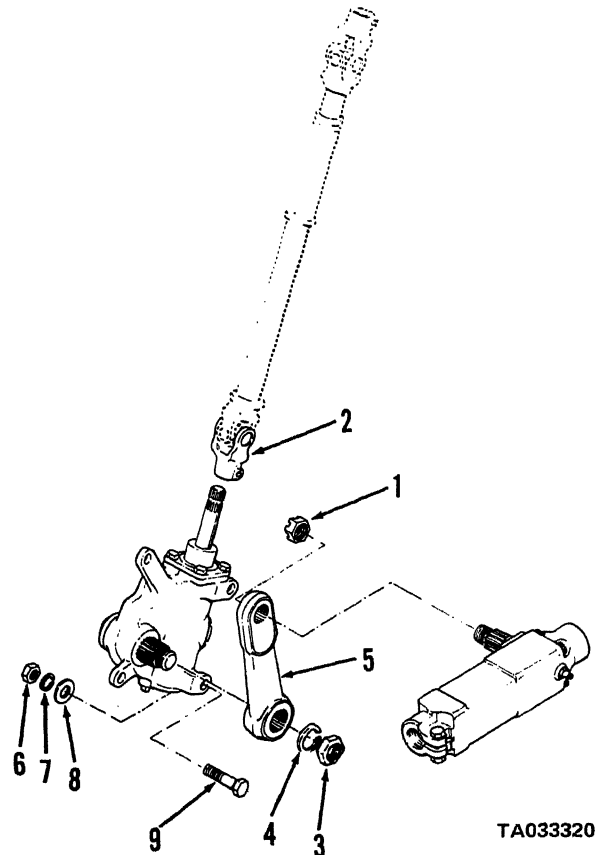
- (1) Remove nut (1) from pitman mounting shaft.
- (2) Scribe an alignment mark on worm shaft and universal coupling joint (2). Remove pinch bolt. Remove joint (2) from worm gear shaft.

(3) Remove nut (3) and lock washer (4) from steering gear shaft.

(4) Using a suitable puller remove pitman arm (5) from steering gear shaft.

CAUTION

Never remove pitman arm (5) by hammering. This can damage steering gear.



TA033320

- 1 Nut
- 2 Universal joint
- 3 Nut
- 4 Lock washer
- 5 Pitman arm
- 6 Nut
- 7 Lock washer
- 8 Washer
- 9 Cap screw

Figure 17-6. Steering gear assembly removal.

(5) Remove nuts (6), lock washers (7), washers (8), and cap screws (9). Lift steering gear box from vehicle.

(6) Remove power steering control valve as described in TM 5-3810-295-12.

b. Refer to figure 17-7 and disassemble the steering worm gear box as follows:

(1) Place the steering gear box in a vise, clamping onto one of the mounting tabs. Keep the steering gear shaft in a horizontal position and the side cover up.

(2) Loosen lock nut (9) and turn adjuster (12) three turns counterclockwise. Remove bolts (1) and washers (2). Remove nut (3) and lock washer (4). Tap lightly on

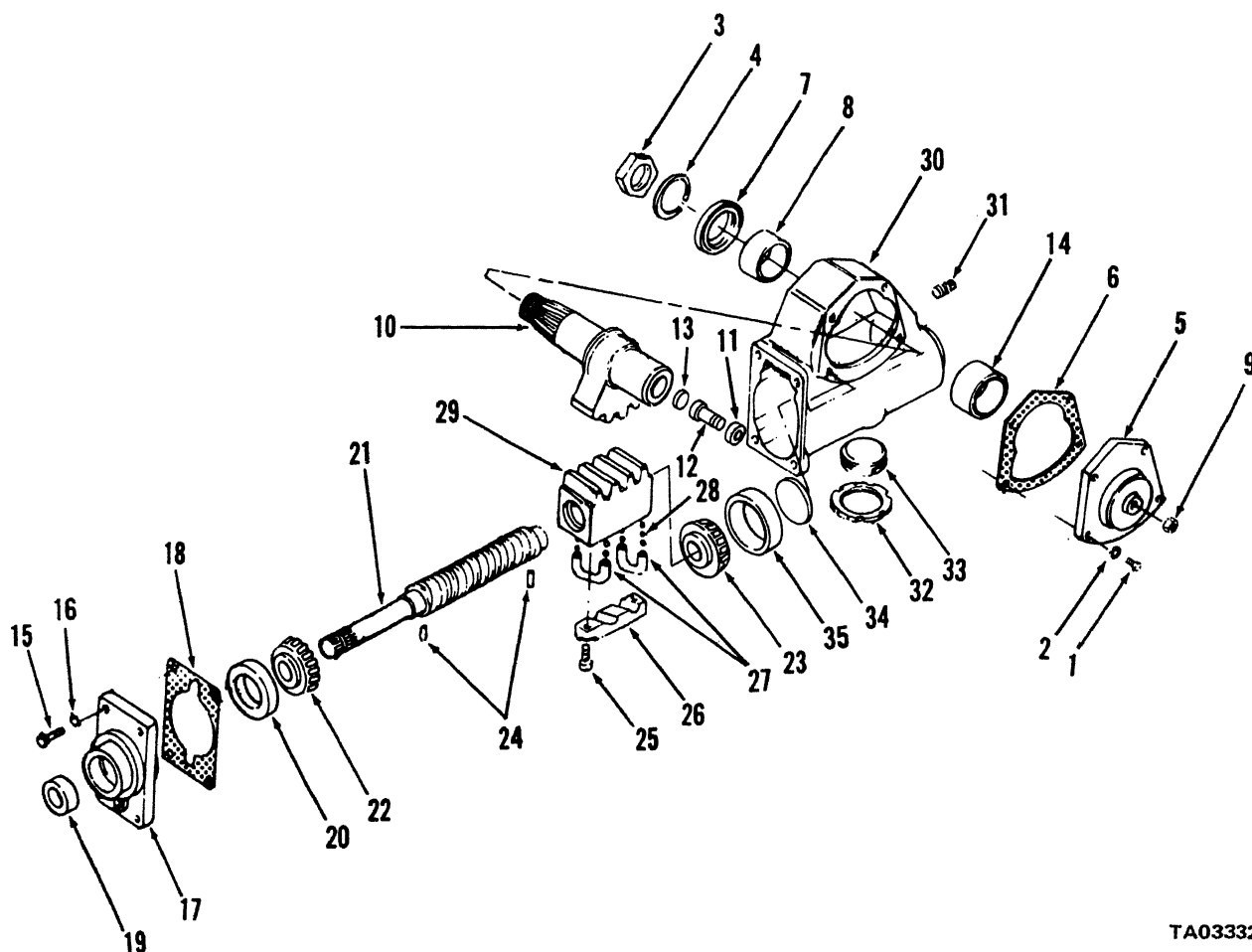
the end of the pitman shaft with a soft headed hammer and remove side cover (5) and pitman shaft assembly (10) from gear housing (30).

NOTE

If sector gear (10) does not easily clear housing opening, rotate wormshaft (21) until sector gear passes through the opening in the housing.

(3) Remove and discard gasket (6).

(4) Remove seal (7) by prying out with a screwdriver. Care must be taken not to damage bearings.



TA033321

1 Bolt
2 Washer
3 Nut
4 Lock washer
5 Cover
6 Gasket
7 Seal
8 Needle bearing
9 Lock nut
10 Pitman shaft
11 Retainer
12 Adjuster

13 Washer
14 Needle bearing
15 Cap screw
16 Lock washer
17 Cover
18 Shim
19 Seal
20 Cup
21 Worm shaft
22 Bearing
23 Bearing
24 Ball nut stop

25 Screw
26 Clamp
27 Guide
28 Ball
29 Ball nut
30 Housing
31 Pipe plug
32 Nut
33 Adjuster
34 Expansion plug
35 Cup

Figure 17-7. Steering gear box—exploded view.

(5) Remove needle bearing (8) from housing (30) using a suitable puller.

(6) Remove lock nut (9) from adjuster screw (12). Remove pitman shaft (10) from side cover (5) by turning adjusting screw (12) clockwise.

NOTE

Retainer (11), adjuster screw (12) and washer (13) should not be removed from pitman shaft (10). Retainer (11) is tacked into pitman shaft and complete assembly should be replaced if necessary.

(7) Using a suitable puller, remove needle bearing (14) from side cover (5).

(8) Remove cap screws (15) and lock washers (16) and remove cover (17) from housing (30). Remove shim (18) and record the number removed.

(9) Remove the worm shaft (21) and nut ball (29) assembly from housing (30).

(10) Pry seal (19) out of cover (17) with screwdriver and discard. Care must be taken not to damage seal bore in cover.

(11) Using a suitable puller, remove bearing (23) from housing (30).

(20) from cover (17).

(12) Slide bearing (22) off worm shaft (21) and lift bearing (23) from inside gear housing (30).

(13) Remove ball nut stop (24) from worm shaft (21).

(14) Remove screws (25) and retaining clamp (26) from ball nut (29). Remove guides (27) from ball nut (29).

(15) Remove balls (28) by turning ball nut (29) upside down and rotating the worm shaft (21) back and forth until all balls have dropped out of the nut.

(16) Unscrew ball nut (29) off end of worm shaft (21).

(17) Remove pipe plug (31) from housing (30). Remove lock nut (32) and back-off adjuster (33) from housing (30).

(18) Place gear housing (30) in an arbor press and using a suitable size socket, press expansion plug (34) and bearing cup (35) out of housing (30).

c. Refer to figure 17-8 and disassemble the power steering control valve as follows:

(1) Remove nut (1) from ball stud (5).

(2) Remove dust cover (2) from end housing (7).

(3) Remove lock wire (3) and adjusting plug (4) from end housing (7).

(4) Lift ball stud (5) out of end housing (7).

(5) Remove bolts (6) and separate end housing (7) from valve body (34). Remove grease fitting (8) from end housing (7).

(6) Remove ball stud seats (9), washer (10), and spacer (11) from cap of spool bolt (13) in sleeve (15).

(7) Remove valve spool assembly from valve body (34) and remove nut (12), bolt (13) and washer (14).

NOTE

Sleeve (15) must be held against spools (22) to keep spring (17) from releasing.

(8) Slowly release sleeve (15), removing spring washer (16), centering spring (17), spacer (18), spring washer (19), retainer (20) and preformed packing (21) from valve spool (22).

(9) Remove nut (23), washer (24) and bolt (25). Remove end cap (26) from valve body (34).

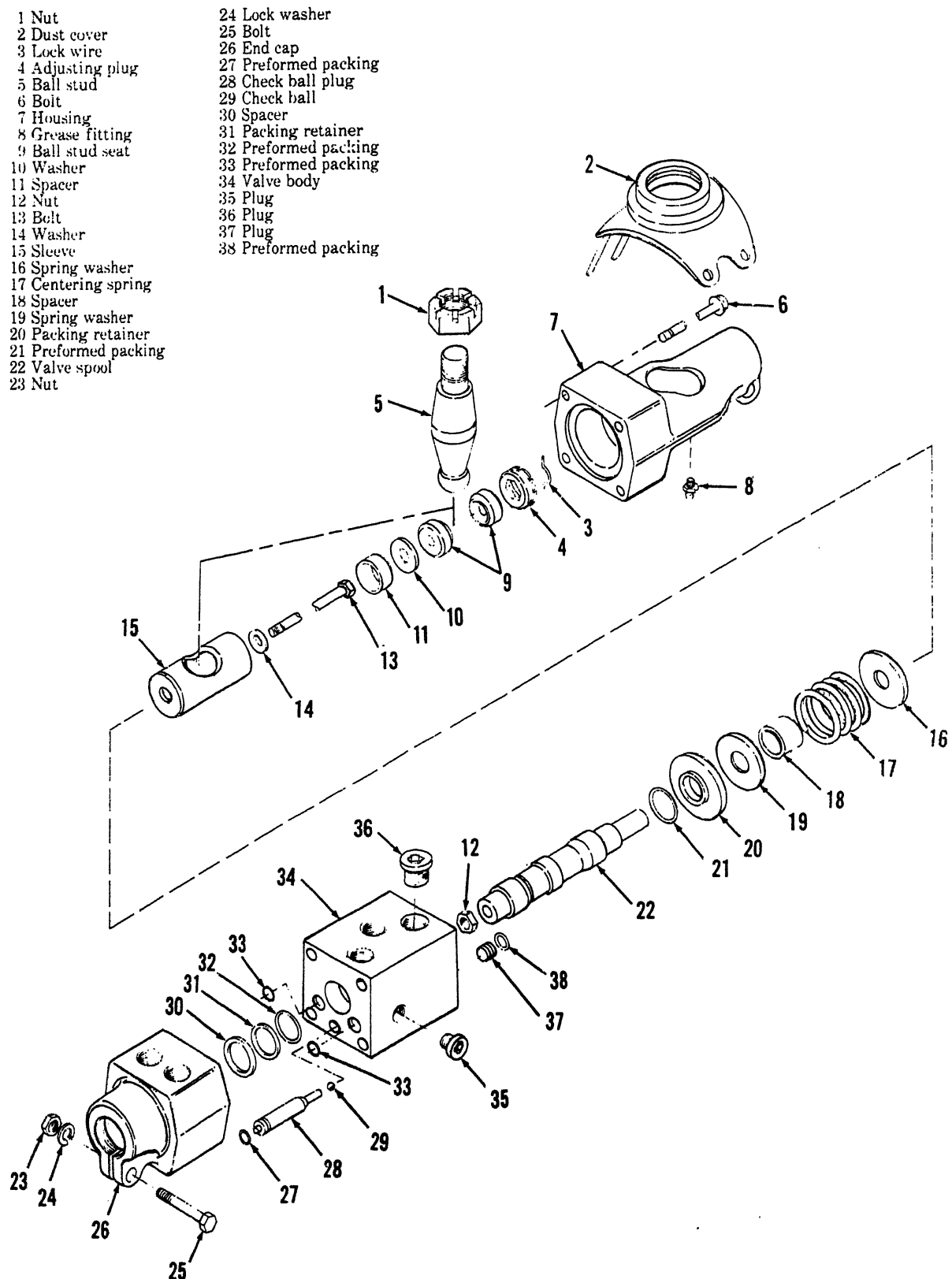
(10) Remove preformed packing (27), check ball plug (28) and ball (29) from valve body (34).

(11) Remove spacer (30), retainer (31) and preformed packing (32) from valve body (34).

(12) Remove preformed packing (33) from valve body (34).

(13) Remove plugs (35) and (36) from valve body (34).

(14) Remove plug (37) and preformed packing (38) from valve body (34).



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Figure 17-8. Power steering control valve—exploded view.

17-12. Cleaning, Inspection and Repair

- a. Discard all seal and preformed packing. Replace with new ones in assembly.
- b. Clean all metal parts with cleaning solvent, (Fed. Spec. P-D-680, or equivalent); dry thoroughly with compressed air.
- c. Inspect all parts for cracks, chips or excessive wear. Replace parts as required.
- d. Replace steering gear worm shaft if bent or damaged.

NOTE

Never attempt to straighten a bent worm shaft.

17-13. Reassembly and Installation

- a. Refer to figure 17-7 and reassemble the steering worm gear box as follows:

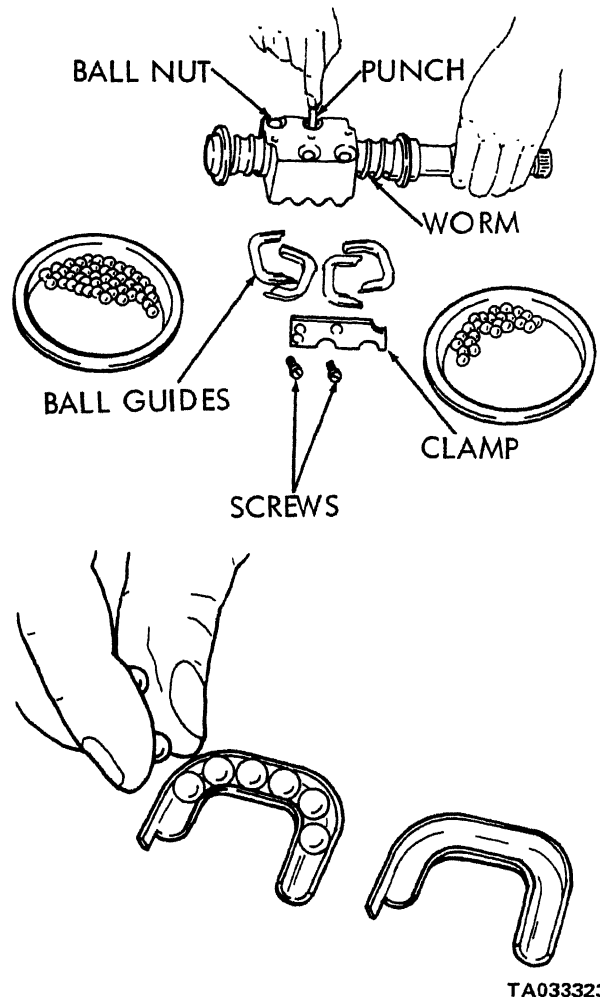
- (1) Place the ball nut (29) over worm shaft (21). Ball guide holes of the ball nut shall be up and the shallow end of the rack to the left from the steering wheel position.

- (2) Install balls (28) into ball nut (29) and guides (27) as follows:

- (a) Place 45 balls (28) equally into two separate containers (fig. 17-9).

- (b) Place balls into guide holes while turning the worm gradually away from that hole. (Fill only one circuit at a time.)

- (c) Continue until the circuit is full from the bottom of one hole to the bottom of the other.



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Figure 17-9. Filling ball nut circuits and guides.

NOTE

If ball nut is stopped by the end of the worm before circuit is full, hold down the balls installed with a blunt end of a clean rod and turn worm shaft in the opposite direction a few turns (fig. 17-9). It may be necessary to turn the worm shaft several times, holding the balls down first in one hole then the other, to close up the spaces between the balls and fill the circuit completely.

(d) With the ball guides (27, fig. 17-7) separated, fill guide (27) with the remaining balls (28).

(e) Set the two halves of guides (27) together and place a small amount of grease at each end so balls (28) will not drop out when installing the guide.

(f) Place guide (27) into the guide holes of ball nut (29). If guide does not go all the way down, tap lightly with a soft headed hammer.

(g) Fill the second ball circuit in the same manner described for the first circuit.

(3) Install clamp (26) over ball guides (27) and secure with bolts (25).

(4) Install nut stops (24). Rotate ball nut (29) on worm shaft (21) from stop to stop to insure that it moves freely.

NOTE

The threads of adjuster (33), cover bolts (1) and adjuster (12) must be coated with a suitable nondrying, oil resistant sealing compound. Sealant should not be applied to female threads and care should be exercised in applying compound to bearing adjuster, as sealant must be kept away from the bearing race. Apply a suitable grease to bearings, bushings and ball nut teeth.

(5) Install new expansion plug (34) in housing (30). Press center of plug (34) to deform it outward and secure it in housing.

(6) Press new bearing cup (35) in housing (30). Cup must be firmly and evenly seated.

(7) Install pipe plug (31) in housing (30).

(8) Install bearing (22) and (23) on worm shaft

(15) Place pitman shaft (10) into cover (5). Using a screwdriver through hole in side cover (5), turn the adjusting screw (12) counterclockwise to pull pitman shift (10) completely into cover. Back-off adjusting screw (12) one-half turn.

(16) Rotate worm shaft until ball nut (29) is centered. Pack gear housing (30) with a suitable clean lubricant.

CAUTION

Tape serrations on end of pitman shaft (10), to prevent damage to seal (7).

(17) Place new gasket (6) on side cover (5) and carefully place pitman shaft (10) part way into housing (30) and add additional lubricant. Place pitman shaft (10) the rest of the way into housing (30).

(18) Make sure there is some lash between ball nut (29) and sector gear (10) and install washers (2) and bolts (1). Tighten to 35 ft-lb (47.4 N • m) torque.

(19) Install adjuster (33) and lock nut (32). Screw adjuster in until it bottoms, back it off one-eighth to one-fourth turn and tighten lock nut to 85 ft-lb (115.2 N • m) torque.

(20) Assemble lock washer (4) and nut (3) to end of pitman shaft.

(21) Perform adjustments as described in paragraph 17-10.

b. Refer to figure 17-8 and reassemble the power steering control valve as follows:

(1) Assemble new preformed packing (38) and plug (37) to valve body (34).

(2) Install plug (36) and (35) to valve body (34).

(3) Install new preformed packing (33) and (32), retainer (31) and spacer (30).

(4) Assemble check ball (29), check ball plug (28) and preformed packing (27) to valve body (34).

(5) Assemble valve spool assembly (22) by placing preformed packing (21), retainer (20), spring washer (19), spacer (18), spring (17), spring washer (16), and sleeve (15) on spool (22). Secure in place with washer (14), bolt (13) and nut (12).

(6) Install valve spool assembly (22) in valve body (34).

(7) Install spacer (11), washer (10) and ball seats (9) on cap of spool bolt (13).

(8) Assemble end housings (7) and (26) to valve body (34) and secure with bolts (6).

(9) Assemble bolt (25), lock washer (24) and nut (23) to end housing (26).

(10) Place ball stud (5) through end housing (7) and sleeve (15) between ball stud seats (9).

(11) Install adjusting plug (4) and adjust excess play from ball stud (5). Install lock wire (3).

(12) Place dust cover (2) over end housing (7) and secure with clips.

(13) Place nut (1) on ball stud (5).

c. Refer to figure 17-6 and install the steering worm

gear box and power steering control valve as described in the following steps.

(1) Place power steering control valve on linkage and connect all hydraulic lines tagged for the power steering valve.

(2) Position steering wheel in a straight-ahead position and steering gear in center position.

(3) Place steering worm gear box in vehicle frame side member, and at the same time slide worm shaft into joint (2).

NOTE

Match marks on joint (2) and worm gear shaft should be aligned.

(4) Secure steering gear box with cap screw (9) washers (8), lock washers (7) and nuts (6).

(5) Install pinch bolt on joint (2) and tighten securely.

(6) Align pitman arm (5) with steer gear box shaft and press arm on shaft. Install washer (4) and nut (3). Tighten nut (3) to 275 ft-lb (372.9 N · m) torque.

(7) Press pitman arm (5) on power steering control valve and secure with nut (1).

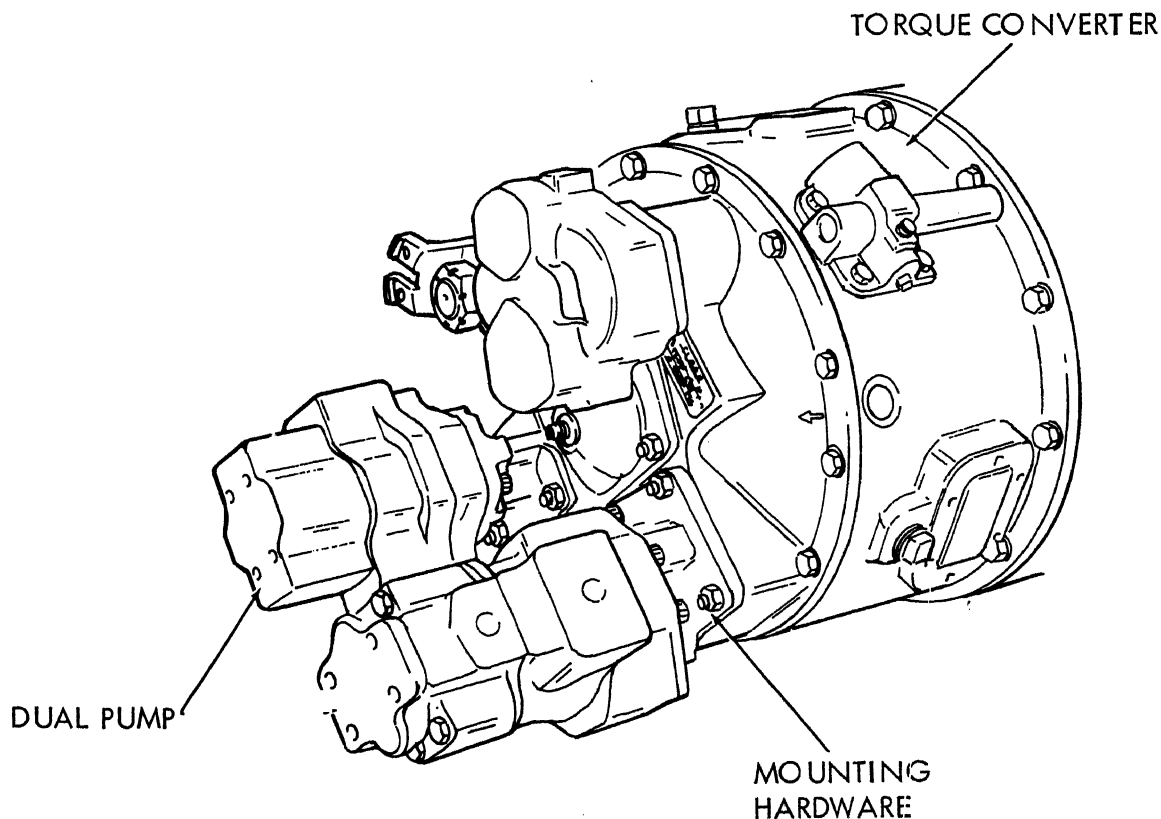
Section IV. REPAIR OF DUAL STEERING AND EMERGENCY STEERING PUMP ASSEMBLIES

17-14. Description

a. The dual steering pump is mounted on and driven by the torque converter. This pump has a capacity of 18—24 gpm per pump and supplies hydraulic pressure for the steering cylinders. One side of the dual pump supplies pressure for the front wheel cylinders, the other side supplies pressure for the rear steer cylinders.

See figure 17-10 for mounting location.

b. The emergency steering pump is a single hydraulic pump mounted on and driven by the transmission. This pump is used to supply hydraulic pressure to the steering system in case of engine failure. See figure 17-11 for mounting location.



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Figure 17-10. Dual steering pump mounting.

17-15. Removal and Disassembly

a. Refer to figure 17-12 and remove and disassemble the dual steering pump as follows:

(1) Tag and disconnect all hydraulic lines to the pump.

(2) Remove cap screws (1) and lock washers (2). Lift pump from torque converter. Remove gasket (3).

NOTE

For correct reassembly, mark pump body (27), inlet housing (25), and cover (5).

(3) Mount pump assembly in a vise with protective jaws.

(4) Remove cap screws (4) and lift pump cover (5) off pump housing (25). Pull cartridge assembly from housing.

(5) Remove pipe plug (6) and valve retainer (7). Remove pipe plug (8), compression spring (9) and check valve (10).

(6) Remove preformed packing (11), (12) and (13), and backup rings (14) and (15) from pressure plate (20).

(7) Remove screws (16) and lift off wear plate (17). Remove ring (18) and rotor assembly (19) from pressure plate (20).

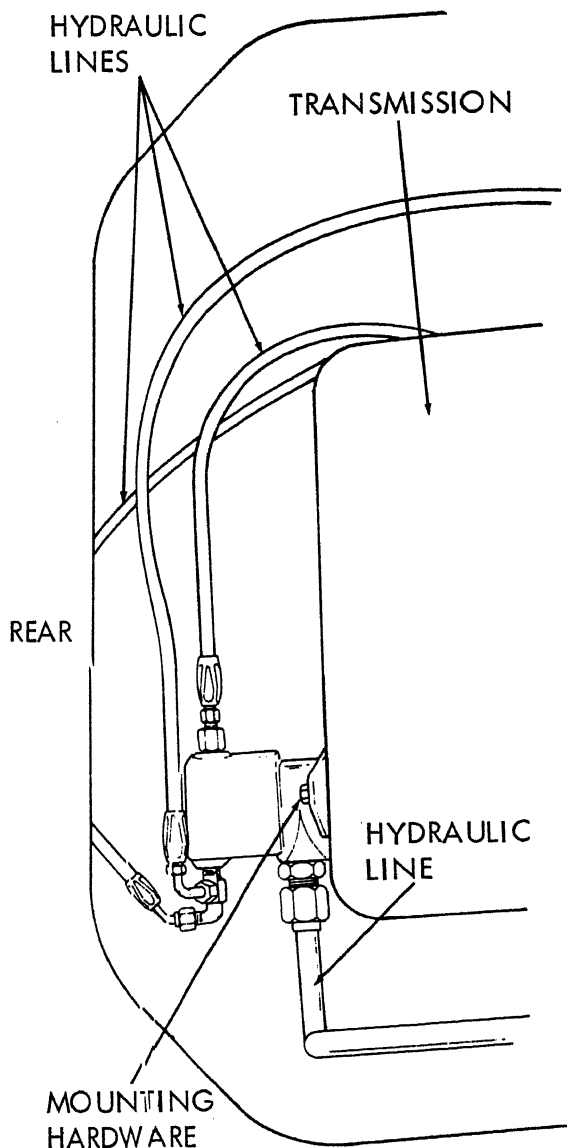
NOTE

Position of ring (18), rotor (19), pressure plate (20), vanes (21) and intra vanes (22) should be noted.

(8) Remove vanes (21) and intra vanes (22) from rotor (19). Remove locating pin (23) from housing (25).

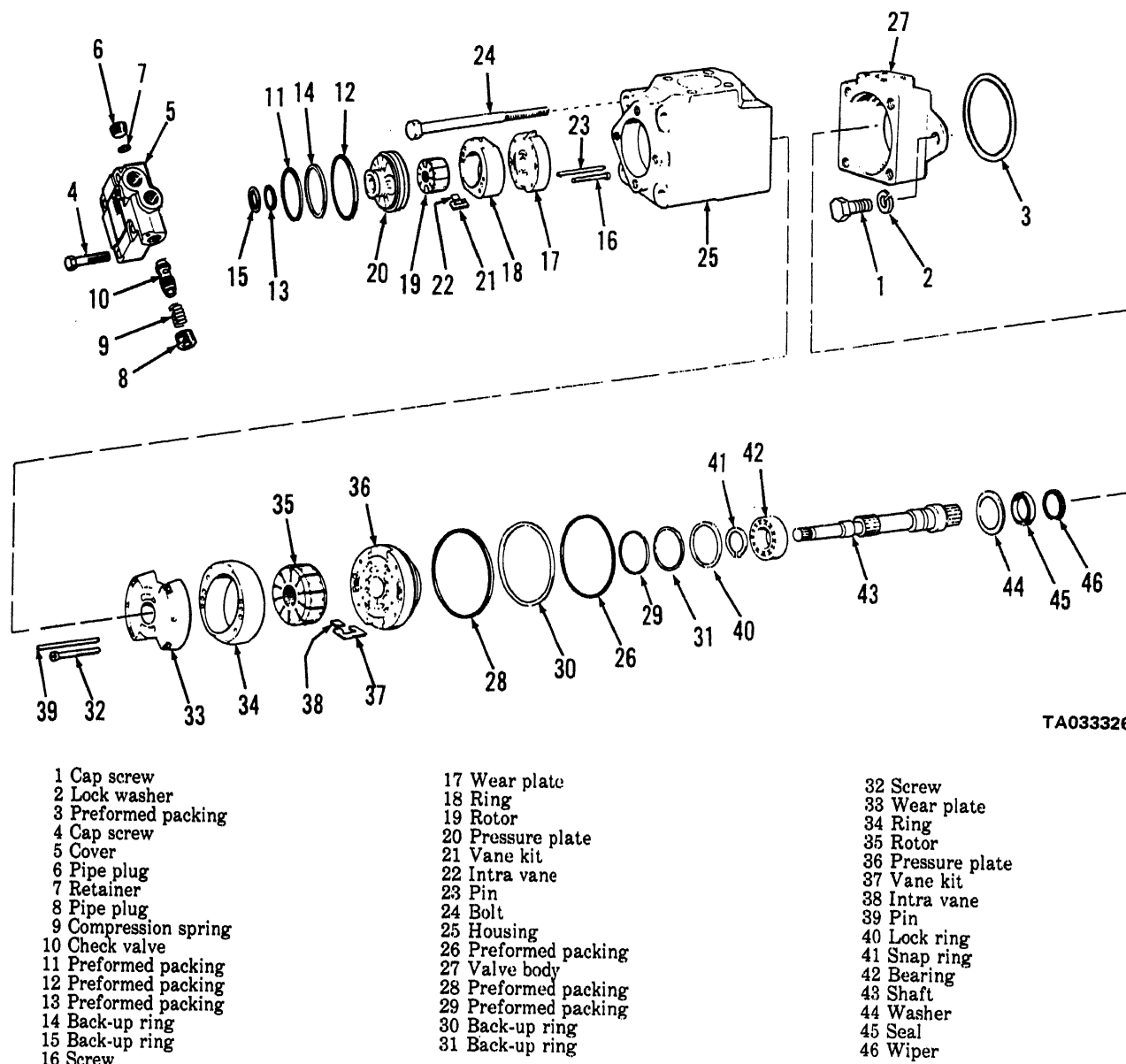
(9) Remove bolts (24) and separate housing (25) and valve body (27). Remove and discard preformed packing (26).

(10) Rotate shaft (43) and remove cartridge assembly from housing (25). Pull cartridge assembly off shaft (43).



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Figure 17-11. Emergency steering pump mounting.



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Figure 17-12. Dual steering hydraulic pump—exploded view.

(11) Remove preformed packing (28) and (29) and back-up rings (30) and (31) from pressure plate (36).

(12) Remove screws (32) and lift wear plate (33). Remove ring (34) and rotor assembly (35) from pressure plate (36).

NOTE

Note position of ring (34), rotor (35), pressure plate (36), vanes (21), intra vanes (22) and locating pin (39).

(13) Remove vanes (37) and intra vanes (38) from rotor (35). Remove locating pin (39) from housing (25).

(14) Remove lock ring (40) and pull shaft and

bearing assembly from valve body (27).

(15) Remove snap ring (41) and press shaft (43) out of bearing (42), supporting bearing inner race.

(16) Remove washer (44) and drive shaft seal (45) and wiper (46) out the shaft end of body (27).

b. Refer to figure 17-13 and remove and disassemble the emergency steering pump as follows:

(1) Tag and disconnect all hydraulic lines to the pump.

(2) Remove cap screws (1) and lock washers (2). Remove pump assembly from transmission.

(3) Mark cover (4), ring (17) and body (23). Note

the direction of arrow cast into ring (17). The arrow indicates the direction of pump rotation.

(4) With cover end up, mount pump assembly in a vise with protective jaws.

(5) Remove bolts (3) and lift cover (4) off pump assembly.

(6) Remove pipe plugs (5) and (6). Insert a screwdriver in bore for plug (5) and push spring (7) and piston (8) out of cover (4).

CAUTION

When inserting screwdriver in control valve bore, do not score valve bore.

(7) Remove pipe plug (9), shims (10) and (11),

spring (12), poppet (13) and seat (14) from cover (4).

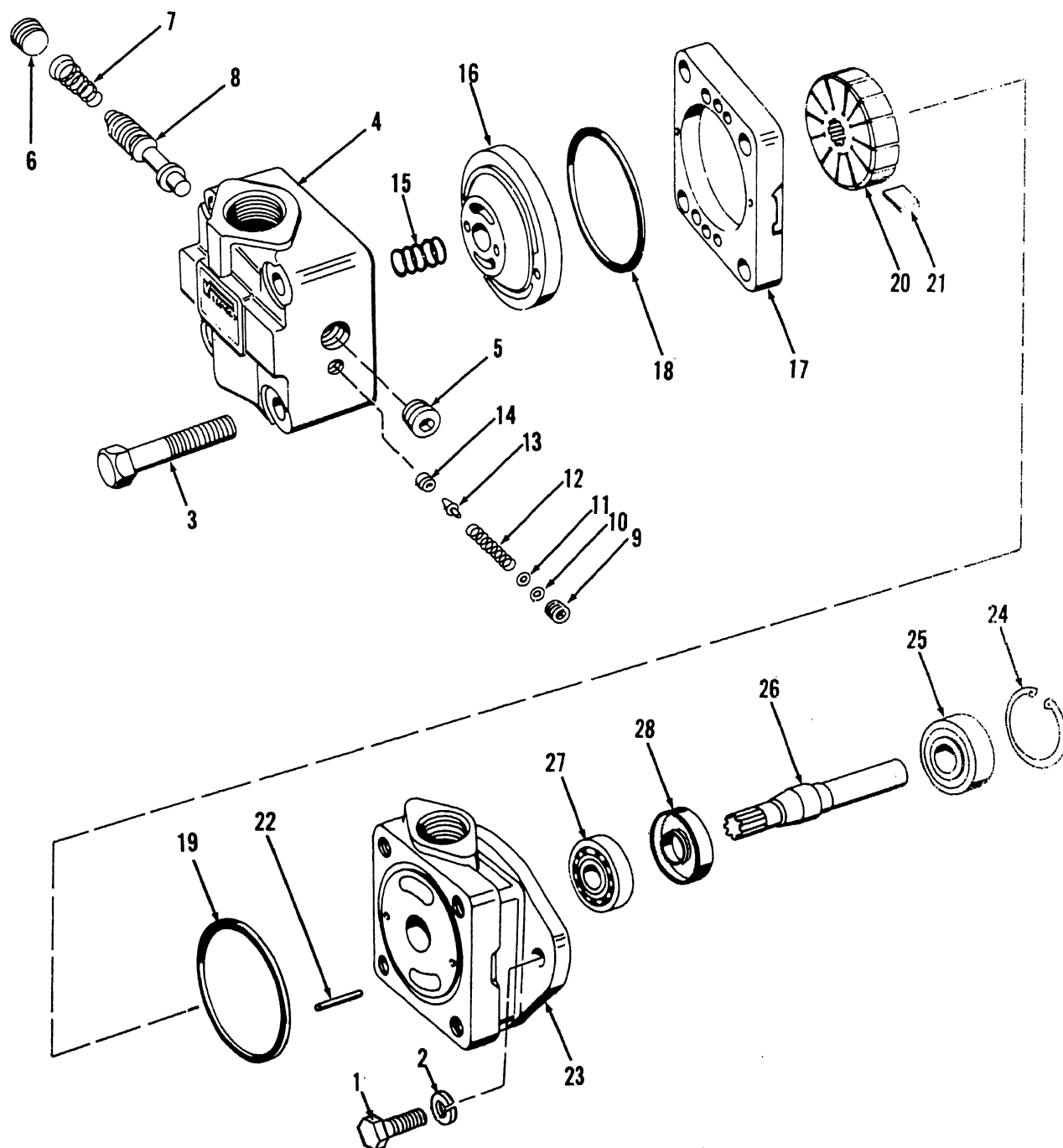
(8) Remove ring and cartridge assembly from valve body (23). Separate pressure plate (16) from ring (17).

(9) Remove spring (15) from pressure plate (16). Remove preformed packing (18) and (19) from ring (17).

(10) Remove rotor (20) from ring (17) and pump vanes (21) from rotor (20).

(11) Remove snap ring (24) from valve body (23). Tap shaft and bearing assembly out of valve body (23).

(12) Remove bearing (25) from shaft (26). Remove bearing (27) and seal (28) from shaft (26).



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- | | | | |
|---------------|-------------|----------------------|--------------|
| 1 Cap screw | 8 Piston | 15 Spring | 22 Pin |
| 2 Lock washer | 9 Pipe plug | 16 Pressure plate | 23 Body |
| 3 Bolt | 10 Shim | 17 Ring | 24 Snap ring |
| 4 Cover | 11 Shim | 18 Preformed packing | 25 Bearing |
| 5 Pipe plug | 12 Spring | 19 Preformed packing | 26 Shaft |
| 6 Pipe plug | 13 Poppet | 20 Rotor | 27 Bearing |
| 7 Spring | 14 Seat | 21 Vanes | 28 Seal |

Figure 17-13. Emergency steering hydraulic pump—exploded view.

17-16. Cleaning, Inspection and Repair

a. Replace all seals and preformed packing for reassembly.

b. Clean all metal parts with cleaning solvent (Fed. Spec. P-D-680, or equivalent) dry thoroughly with compressed air.

c. Check wearing surfaces of cartridge parts for scoring and excessive wear. Light score marks should be removed by lapping. Parts with excessive scoring or wear should be replaced.

d. Inspect vanes for burrs, wear and excessive play in rotor slots. Dress down burrs carefully, with a medium India stone. Rotors with worn slots should be replaced. If vane tips are scored replace vanes with a vane kit.

e. Check bearings for wear, looseness, roughness and pitted or cracked races by rotating bearings on the shafts while applying pressure. Replace defective bearings.

f. Inspect seal and bushing mating surfaces on shafts for scoring or wear. Replace any shaft that the wear marks cannot be removed by light polishing.

g. Check body and cover mating surfaces for paint or burrs. Remove any paint or burrs prior to reassembly.

17-17. Reassembly and Installation

a. Refer to figure 17-12 and reassemble and install dual steering hydraulic pump as follows:

(1) Install new wiper (46) and seal (45) in body (27). The OD of seal (45) must be below the chamfer in body (27). Place bearing washer (44) against seal (45).

NOTE

Soak new wiper (46) in clean engine oil prior to assembly.

(2) Press shaft (43) into bearing (42) with an arbor press. Support inner race of bearing (42). Install snap ring (41) on shaft (43).

(3) Cover shaft end and lubricate with grease or petroleum jelly to protect seal. Gently tap shaft (43) and bearing (42) into body (27). Install lock ring (40).

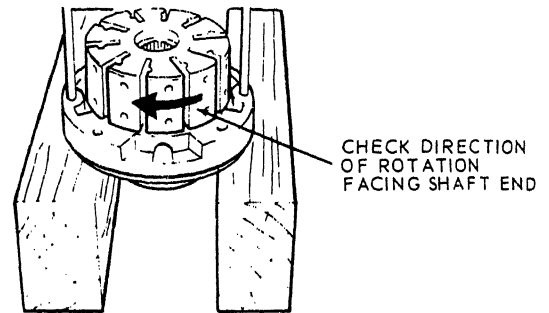
NOTE

The direction of rotation is as viewed from the shaft end; right hand rotations is clockwise; left hand counterclockwise.

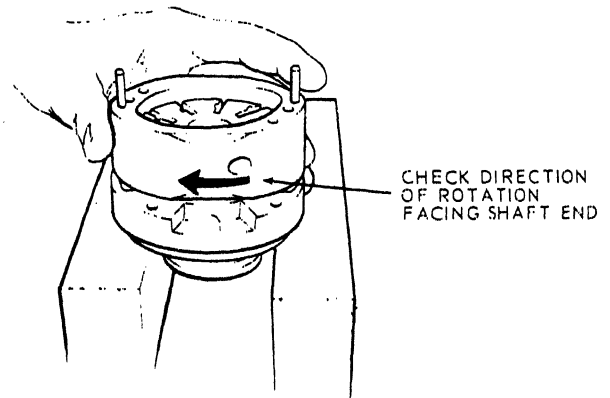
(4) Place pressure plate (36) on blocks as shown in figure 17-14. Set rotor (35, fig 17-12) on plate (36) with the arrow pointed in correct direction of rotation (fig. 17-14, step 1).

(5) Install locating pins (39, fig. 17-12) and position ring (34) over pins (39) and rotor (35), again observing the rotation arrow (fig. 17-14, step 2).

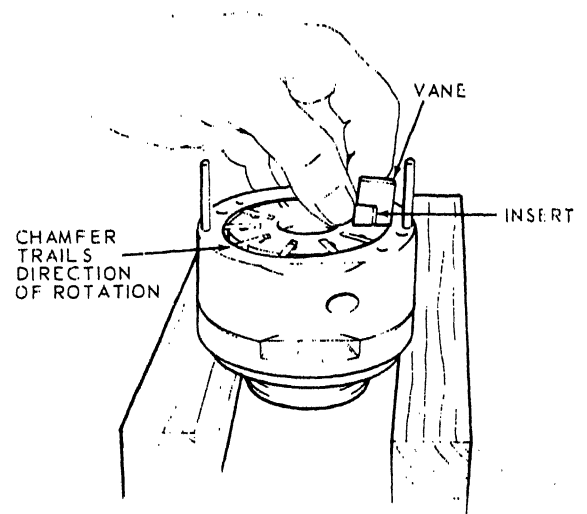
(6) Install intra vanes (38, fig. 17-12) in vanes (37) and place both in rotor slots with the sharp edges toward the direction of rotation (fig. 17-14, step 3). Both vanes (37, fig. 17-12) and intra vanes (38) must move freely in the rotor slots.



STEP 1 - ROTOR INSTALLATION



STEP 2 - RING INSTALLATION



STEP 3 - VANE AND INSERTS INSTALLATION

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Figure 17-14. Dual steering hydraulic pump, reassembly.

(7) Install wear plate (33) and secure with screws (32).

(8) Install new preformed packing (29) and back-up ring (31) on pressure plate hub (36).

(9) Lay preformed packing (26) in place and install back-up ring (30) and preformed packing (28) on cartridge assembly.

(10) Install cartridge assembly in body (27) so one of the chamfers on ring (34) will align with inlet port on inlet housing (25).

(11) Place inlet housing (25) over the cartridge assembly so locating pins (39) are properly engaged.

NOTE

Inlet must be in correct position with respect to body outlet as marked in disassembly.

(12) Install bolts (24) and tighten evenly to 90—95 ft-lb (122.0—128.8 N·m) torque.

(13) Assemble pressure plate (20), rotor (19), vanes (21), intra vanes (22), ring (18), locating pins (23), wear plate (17) and screw (16) as described in (4), (5) and (6) above.

(14) Install cover cartridge assembly in housing (25). Locating pins (23) must engage housing.

(15) Place back-up ring (14) and preformed packing (12) on pressure plate (20).

(16) Install preformed packing (13) and back-up ring (15) on pressure plate hub.

(17) Install preformed packing (11) on cover (5) and assemble to housing (25). Secure with cap screws (4). Tighten cap screws (4) to 45—50 ft-lb (61.0—67.8 N·m) torque.

(18) Install check valve (10), spring (9) and pipe plug (8) in cover (5).

(19) Install retainer (7) and pipe plug (6) in cover (5).

(20) Install new gasket (3) and secure pump assembly to torque converter with lock washers (2) and

cap screws (1).

(21) Reconnect all hydraulic lines, as tagged, to the pump assembly.

b. Refer to figure 17-13 and reassemble and install the emergency steering pump as follows:

(1) Press shaft (26) through seal (28) and bearing (27) using an arbor press while supporting bearing (27) inner race.

(2) Assemble bearing (25) to shaft (26) and install bearing and shaft assembly into valve body (23). Secure in body with snap ring (24).

(3) Place rotor (20) on pressure plate (16) and insert vanes (21) in rotor slots.

NOTE

The radius edges of vanes (21) must be toward ring (17).

(4) Install location pins (22) in pressure plate (16). Place preformed packing (18) on plate (16) and install ring (17) over pins (22) with the ring arrow pointing in the correct direction of rotation.

(5) Install preformed packing (19) in groove of valve body (23).

(6) Place spring (15) in cover (4) and assemble cover (4) and cartridge and ring assembly to valve body (23) with bolts (3). Tighten bolts (3) to 75—85 ft-lb (101.7—115.2 N·m) torque.

(7) Install seat (14), poppet (13), spring (12) shims (11) and (10), and pipe plug (9) to valve cover (4).

NOTE

Use original shims (10) and (11) for reassembly.

(8) Install piston (8), spring (7) and pipe plug (6) to valve cover (4). Install pipe plug (5).

(9) Install emergency steer pump on transmission and secure with lock washers (2) and cap screws (1).

(10) Reconnect all lines, as tagged, to the emergency steer pump.

Section V. REPAIR OF STEERING SELECTOR CONTROL VALVE

17-18. Description

The steering selector control valve is mounted on the carrier cab floor to the right of the operator. This valve allows the operator to select front steer, four wheel steer, or crab position steering.

17-19. Removal and Disassembly

a. Refer to figure 17-15 and remove the selector control valve as described in the following:

(1) Tag and disconnect all hydraulic lines to the valve.

(2) Remove cap screw (1) and lock washer (2). Lift selector control valve from the cab.

b. Refer to figure 17-15 and disassemble selector control valve as follows:

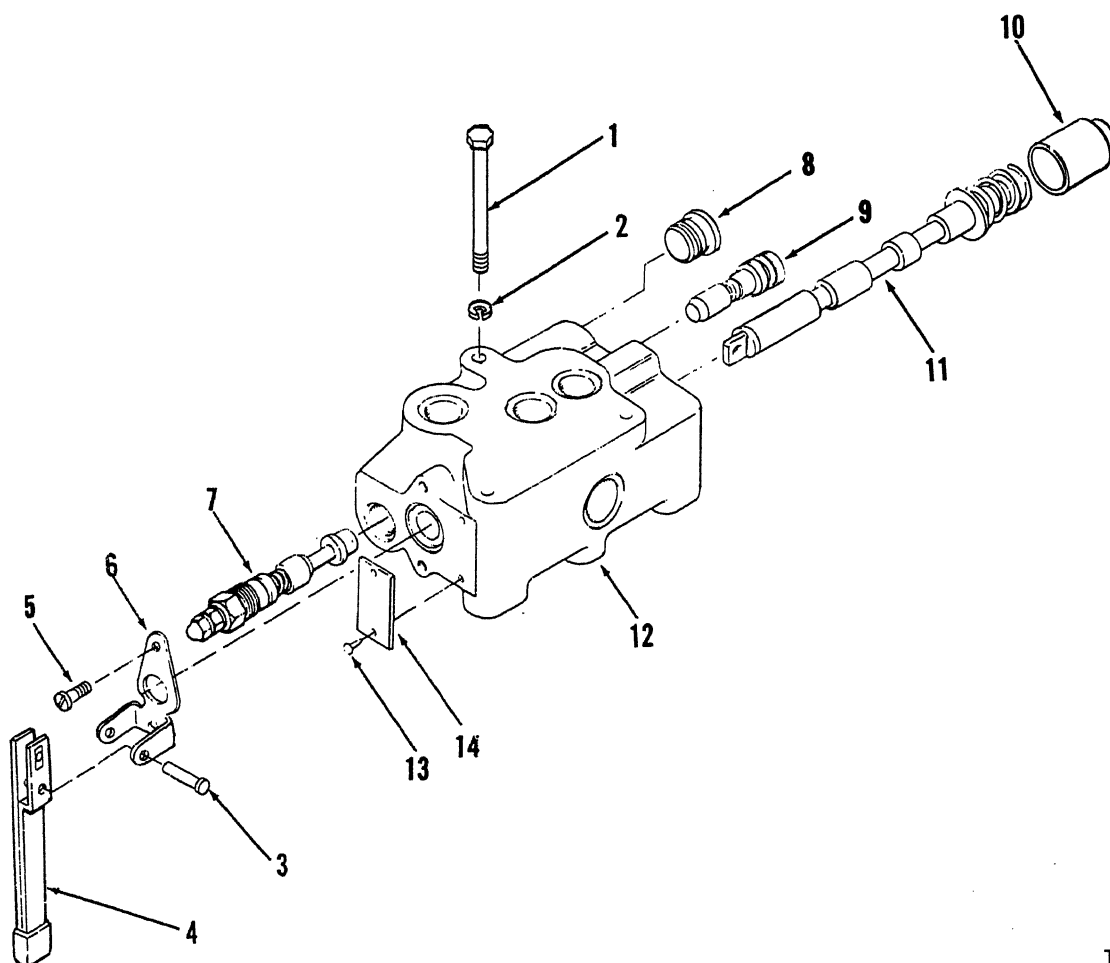
(1) Remove pin (3) and lift handle (4) off valve.

(2) Remove screws (5) and spool seal (6) from valve body (12).

(3) Unscrew relief valve (7) from valve body (12). Remove plug (8).

(4) Remove check valve (9) and valve cap (10). Push spool assembly (11) from valve body (12).

(5) Remove screws (13) and nameplate (14) if required.



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- 1 Cap screw
- 2 Lock washer
- 3 Pin
- 4 Handle
- 5 Screw
- 6 Spool seal
- 7 Relief valve

- 8 Pipe plug
- 9 Check valve
- 10 Valve cap
- 11 Spool
- 12 Valve body
- 13 Screw
- 14 Nameplate

Figure 17-15. Steering selector control valve—exploded view.

17-20. Cleaning, Inspection, Repair

a. Clean all metal parts with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly with compressed air.

b. Inspect all parts for cracks, scoring, corrosion, or other defects.

c. Replace all gaskets, preformed packing and other damaged or defective parts.

17-21. Reassembly and Installation

a. Refer to figure 17-15 and reassemble selector control valve as follows:

(1) Coat all metal parts with clean engine oil to provide initial lubrication and ease of assembly.

(2) Install nameplate (14) on body (12) and secure

with screws (13).

(3) Push spool assembly (11) into body (12) and install spool cap (10).

(4) Install check valve (9) and pipe plug (8) into valve body (12).

(5) Install relief valve (7). Place spool seal (6) in position and install screws (5).

(6) Attach handle (4) to spool assembly (11) and install pin (3) through spool seal (6) and handle (4).

b. Install selector control valve as follows:

(1) Place valve in position in carrier cab and install lock washers (2) and screws (1).

(2) Connect hydraulic lines tagged for the selector control valve during removal.

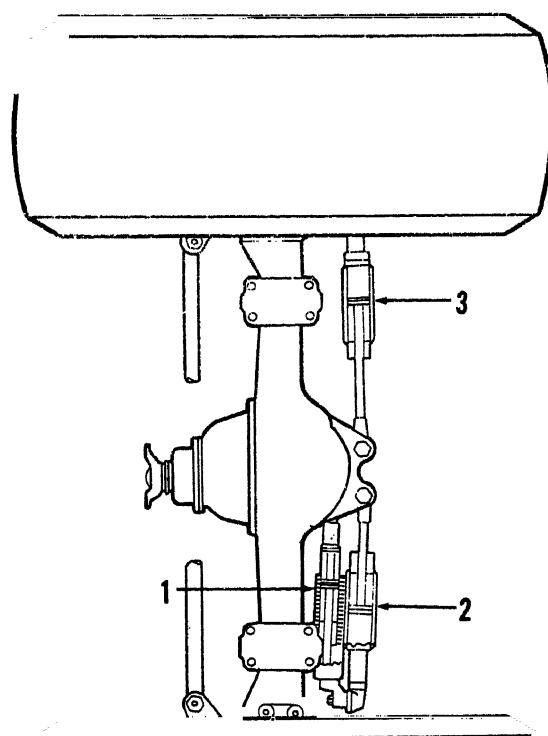
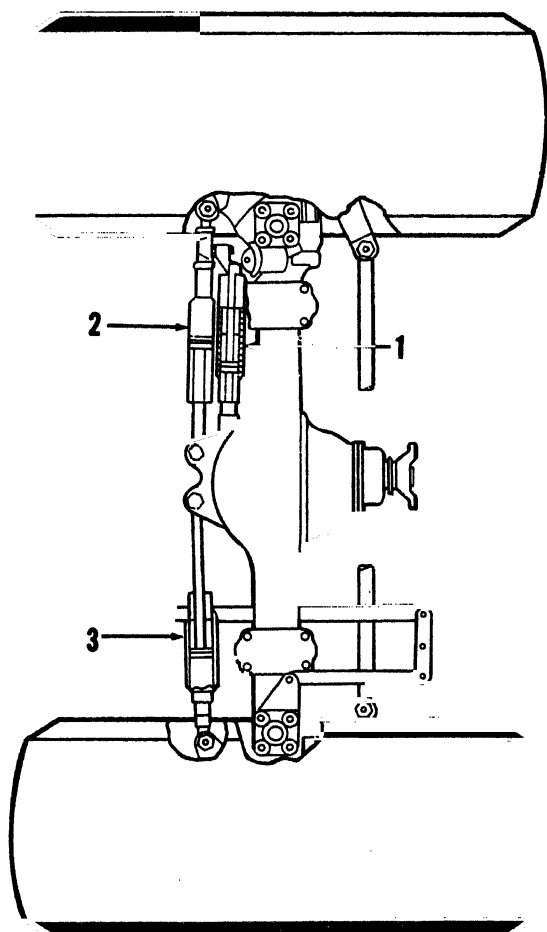
Section VI. REPAIR OF HYDRAULIC STEERING CYLINDERS

17-22. Description

There are three hydraulic cylinders used in each of the front wheel steering and rear wheel steering systems.

The three cylinders: (1) selfcentering cylinder, (2) tandem unit steering cylinder and (3) steering cylinder are located as shown on figure 17-16.

1. SELF-CENTERING STEERING CYLINDER
2. TANDEM UNIT STEERING CYLINDER
3. STEERING CYLINDER



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Figure 17-16. Hydraulic steering cylinders.

17-23. Removal and Disassembly

a. Refer to figure 17-17 and remove and disassemble the self-centering cylinders as follows:

(1) Tag and remove all hydraulic lines.

(2) Remove nut (1) and (2). Remove cylinder assembly from vehicle.

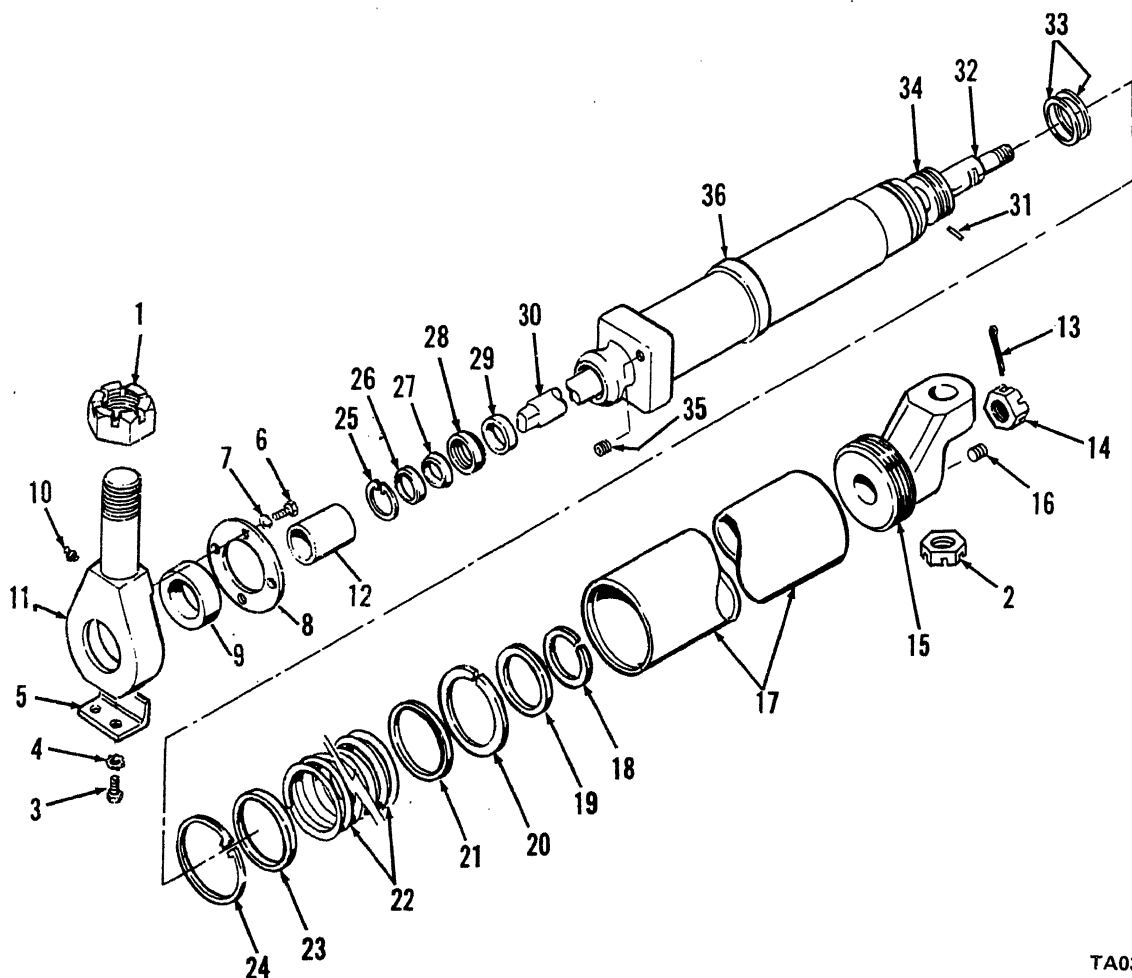
(3) Remove screws (3), lock washers (4) and stop plate (5).

(4) Remove screws (6), lock washers (7) and lift plate (8) off housing (11).

(5) Remove bearing race (9) and grease fitting (10)

from bearing housing (11). Remove dust cover (12).

(6) Remove cotter pin (13) and nut (14) while holding piston rod (30).



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- 1 Nut
- 2 Nut
- 3 Screw
- 4 Lock washer
- 5 Stop plate
- 6 Screw
- 7 Lock washer
- 8 Plate
- 9 Bearing race

- 10 Grease fitting
- 11 Bearing housing
- 12 Dust cover
- 13 Cotter pin
- 14 Nut
- 15 Rod end
- 16 Pipe plug
- 17 Tube
- 18 Retaining ring

- 19 Stop ring
- 20 Retaining ring
- 21 Washer
- 22 Spring
- 23 Washer
- 24 Retaining ring
- 25 Retaining ring
- 26 Scraper
- 27 Wiper

- 28 Retainer
- 29 Seal
- 30 Piston rod
- 31 Roll pin
- 32 Rod
- 33 Piston ring
- 34 Piston
- 35 Pipe plug
- 36 Welded assembly

Figure 17-17. Self-centering steering cylinder—exploded view.

(7) Unscrew rod end (15) from tube (17) and remove pipe plug (16).

(8) Remove tubes (17) from welded assembly (36) and remove ring (18), stop ring (19), retaining ring (20), washer (21), spring (22), washer (23) and retaining ring (24).

(9) Remove retaining ring (25), scraper (26) and wiper (27) from piston rod (30).

(10) Push piston rod (30) through welded assembly

(36) and remove seal retainer (28) and seal (29) from welded assembly (36).

(11) Remove roll pin (31) and slide piston assembly off rod (32).

(12) Remove piston rings (33) from piston (34).

(13) Remove pipe plug (35) from welded assembly (36).

b. Refer to figure 17-18 and remove and disassemble the tandem steering cylinder as follows:

- (1) Remove mounting hardware, cotter pin (1), nut (2), bolt (3), cotter pin (4), nut (5) and bolt (6).
- (2) Tag and disconnect all hydraulic line from the steering cylinder.
- (3) Lift cylinder from vehicle.
- (4) Remove nuts (7), lock washer (8) and bolts (9). Remove rod and bearing assembly (11) and remove fitting (10).
- (5) Remove nut (12), lock washer (13) and bolt

(14). Unscrew bearing assembly (15) and remove fitting (16).

(6) Remove lock wire (17) and adjusting nut (18). Lift ball stud (19) from valve assembly. Remove nut (20) from ball stud (19).

(7) Unclip boot (21) and remove bolts (22). Separate outer sleeve and vent (23), valve body (52) and welded assembly (59). Remove fitting (24) from outer sleeve (23).

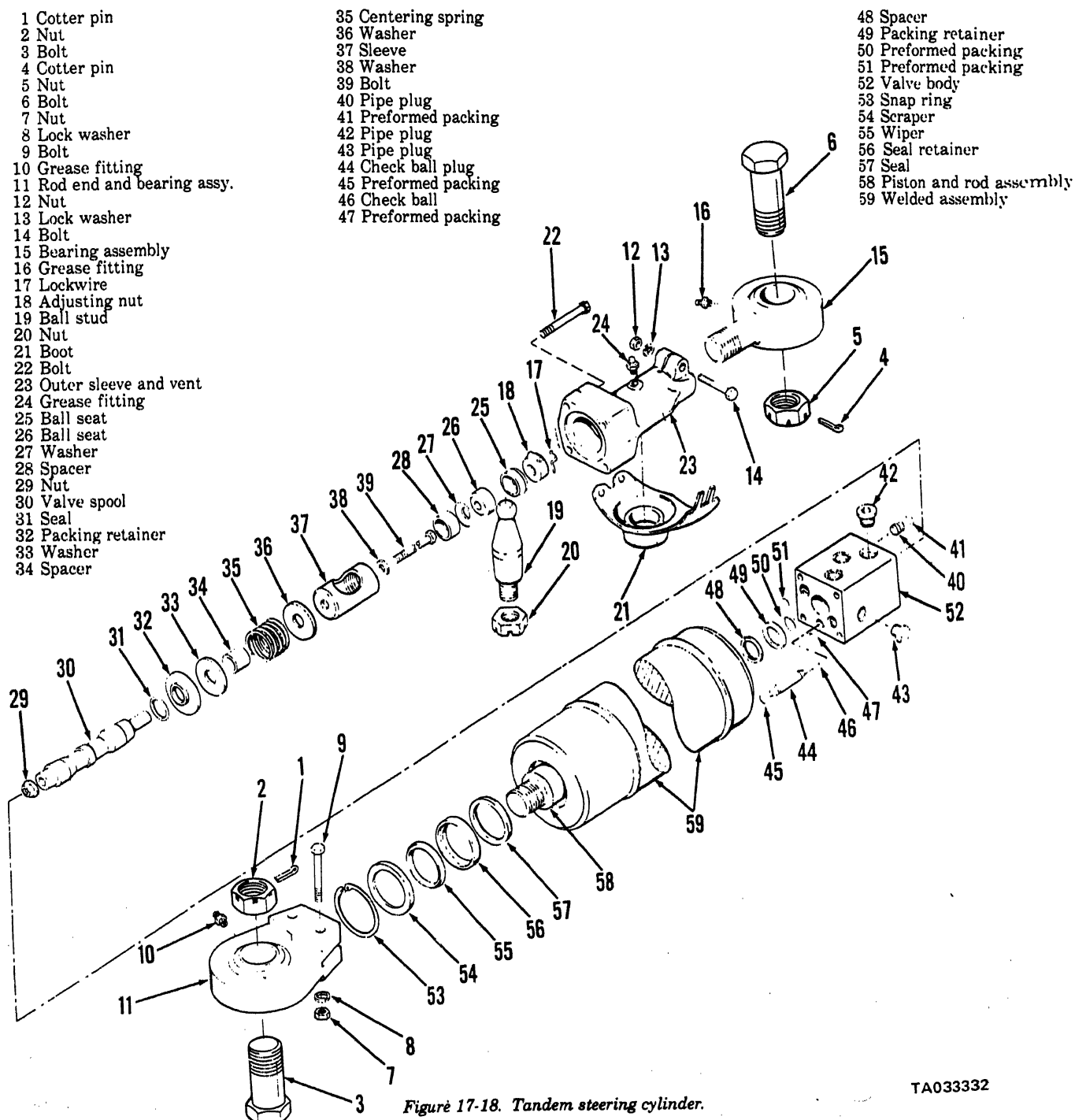


Figure 17-18. Tandem steering cylinder.

TA033332

(8) Remove ball seats (25) and (26), washer (27) and spacer (28) from sleeve (37).

(9) Pull valve spool assembly out of valve body (52) and remove nut (29).

(10) Carefully slide valve spool (30), preformed packing (31), packing retainer (32), washer (33), spacer (34), spring (35), washer (36), sleeve (37), and washer (38) off bolt (39).

(11) Unscrew pipe plug (40) and remove preformed packing (41). Remove pipe plugs (42) and (43).

(12) Pull check ball plug (44) and remove preformed packing (45). Remove check ball (46) and

preformed packing (47).

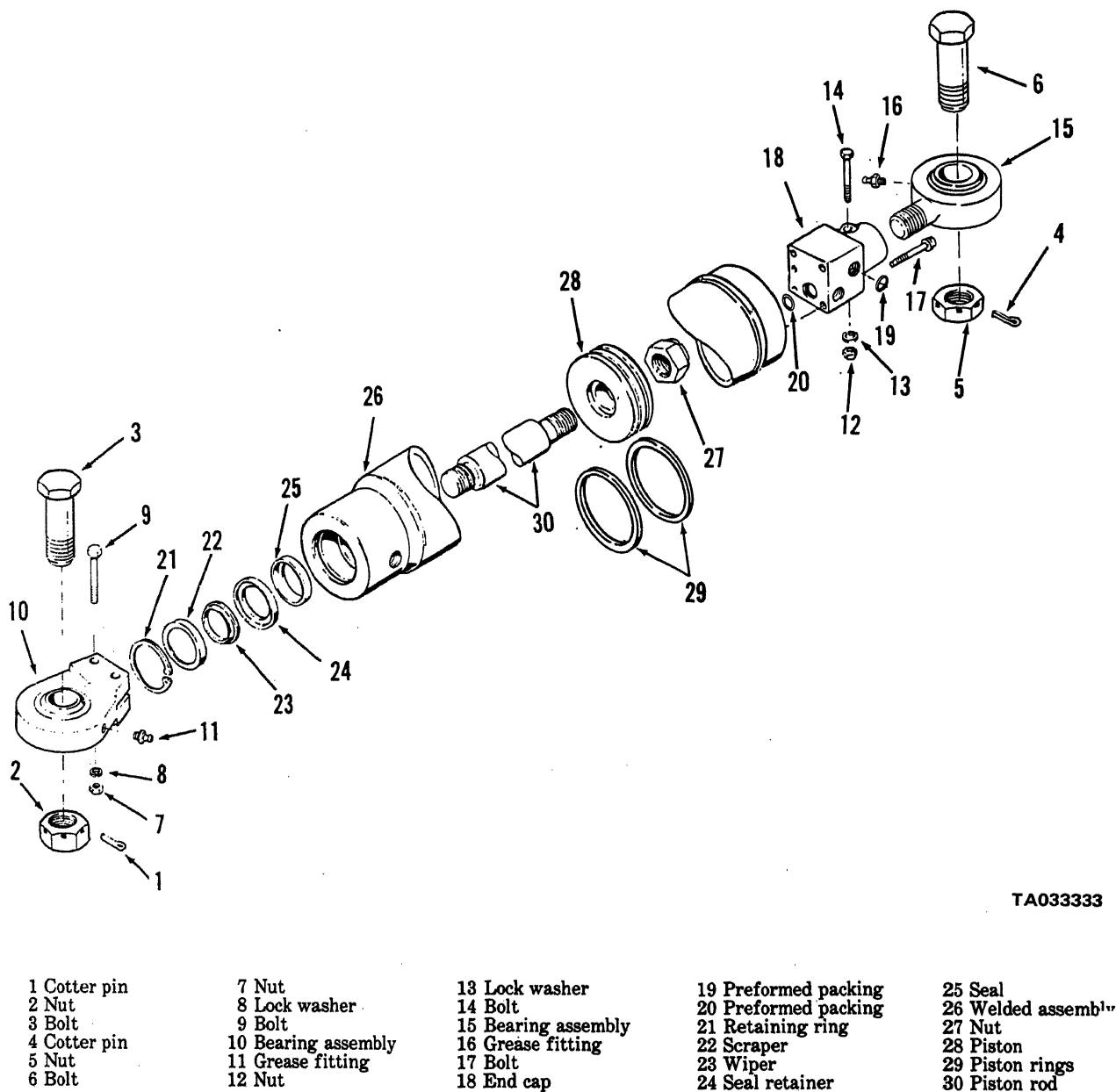
(13) Remove spacer (48), packing retainer (49) and preformed packing (50) and (51).

(14) Remove snap ring (53), scraper (54), wiper (55), seal retainer (56) and seal (57). Push piston and rod assembly (58) out of welded assembly (59).

c. Refer to figure 17-19 and remove and disassemble the steering cylinders as follows:

(1) Tag and disconnect all hydraulic lines to the cylinder.

(2) Remove cotter pin (1), nut (2), bolt (3), cotter pin (4), nut (5) and bolt (6). Remove steering cylinder for disassembly.



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Figure 17-19. Steering cylinder—exploded view.

(3) Remove nuts (7), lock washers (8) and bolts (9). Remove bearing assembly (10) from piston rod (30) and remove grease fitting (11).

(4) Remove nuts (12), lock washers (13) and bolts (14). Remove bearing assembly (15) from end cap (18) and remove grease fitting (16).

(5) Remove bolts (17) and separate end cap (18) and welded assembly (26). Remove and discard preformed packing (19) and (20).

(6) Remove retaining rings (21), scraper (22), wiper (23), seal retainer (24) and seal (25) from welded assembly (26).

NOTE

The welded assembly is made up of the following component parts; nut (27), piston (28), piston rings (29) and rod (30). Assembly cannot be disassembled and component parts serviced separately.

17-24. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent (Fed. Spec. P-D-680, or equivalent). Dry thoroughly with compressed air.

b. Inspect rods, pistons and welded assemblies for cracks, scoring or excessive wear. Repair or replace defective parts and/or assemblies.

c. Replace all packing and seals removed in disassembly.

17-25. Reassembly and Installation

a. Refer to figure 17-17 and reassemble and install the self-centering steering cylinder as follows:

(1) Install pipe plug (35) in welded assembly (36). Install piston rings (33) on piston (34) and slide piston assembly on rod (32). Install new roll pin (31).

(2) Install seal (29) and seal retainer (28) into welded assembly (36), then carefully slide piston and rod assembly through welded assembly and seal.

(3) Place wiper (27) and scraper (26) over piston rod assembly and secure in welded assembly with retaining ring (25).

(4) Install retaining ring (24), washer (23), spring (22), washer (21) and retaining ring (20) into end of welded assembly (36).

(5) Install stop ring (19) and retaining ring (18). Assemble tubes (17) to welded assembly (36).

(6) Install pipe plug (16) to rod end (15) and screw rod end (15) into tube (17). Push piston rod (30) against spring until rod extends through rod end (15). Install nut (14) and cotter pin (13).

(7) Install dust cover (12) and assemble grease fitting (10) and bearing race (9) to housing (11).

(8) Install plate (8) on housing (11) with lock washers (7) and screws (6).

(9) Install stop plate (5) with lock washers (4) and screws (3).

(10) Place cylinder assembly in vehicle and install

nuts (1) and (2).

(11) Connect all hydraulic lines that were disconnected and tagged during removal.

b. Refer to figure 17-18 and reassemble and install the tandem steering cylinders as follows:

(1) Install piston and rod assembly (58) into welded assembly (59). Install seal (57), retainer (56), wiper (55) and scraper (54) secure with snap ring (53).

(2) Assemble preformed packing (51) and (50), retainer (49) and spacer (48) to valve body (52). Place preformed packing (47) and check ball (46) in valve body.

(3) Install preformed packing (45) on check ball plug (44) and install plug in valve body (52).

(4) Install pipe plugs (43) and (42). Place preformed packing (41) on pipe plug (40) and install pipe plug in valve body (52).

(5) Assemble lock washer (38), sleeve (37), washer (36), spring (35), spacer (34), washer (33), retainer (32), seal (31), and valve spool (30) on bolt (39). Install nut (29) to hold components in place.

(6) Install spacer (28), washer (27) and ball seats (26) and (25) in sleeve (37).

(7) Install grease fitting (24) into outer sleeve and vent (23).

(8) Place valve spool into valve body (52) and carefully assemble outer sleeve and vent (23), valve body (52) and welded assembly (59). Secure with bolts (22).

(9) Install ball stud (19) through outer sleeve (23) and sleeve (37). Place ball between ball seats (26) and (25) and secure with nut (18) and lock wire (17).

(10) Clip boot (21) over ball stud (19) and outer sleeve (23). Install nut (20).

(11) Install grease fitting (16) into bearing assembly (15) and screw bearing assembly (15) into outer sleeve and vent (23). Secure in place with bolt (14), lock washer (13) and nut (12).

(12) Install grease fitting (11) in bearing assembly (10). Assemble bearing assembly (10) to piston and rod assembly (58) and secure with bolts (9), lock washers (8) and nuts (7).

(13) Place cylinder assembly in vehicle and secure with bolt (6), nut (5), cotter pin (4), bolt (3), nut (2) and cotter pin (1).

(14) Reconnect all hydraulic lines disconnected and tagged during removal.

c. Refer to figure 17-19 and reassemble and install the steering cylinders as follows:

(1) Install seal (25) and seal retainer (24) in welded assembly (26). Place wiper (23) and scraper (22) over rod (30) and secure with retaining ring (21).

(2) Install new preformed packing (19) and (20) and assemble end cap (18) to welded assembly (26) with bolts (17).

(3) Assemble grease fitting (16) to bearing assem-

bly (15) and install bearing assembly (15) to end cap (18). Secure with bolt (14), lock washer (13) and nut (12).

(4) Assemble grease fitting (11) to bearing assembly (10) and install bearing assembly (10) to rod (30).

Secure with bolts (9), lock washers (8) and nuts (7).

(5) Place steering cylinders in vehicle and install bolt (6), nut (5), cotter pin (4), bolt (3), nut (2) and cotter pin (1).

CHAPTER 18

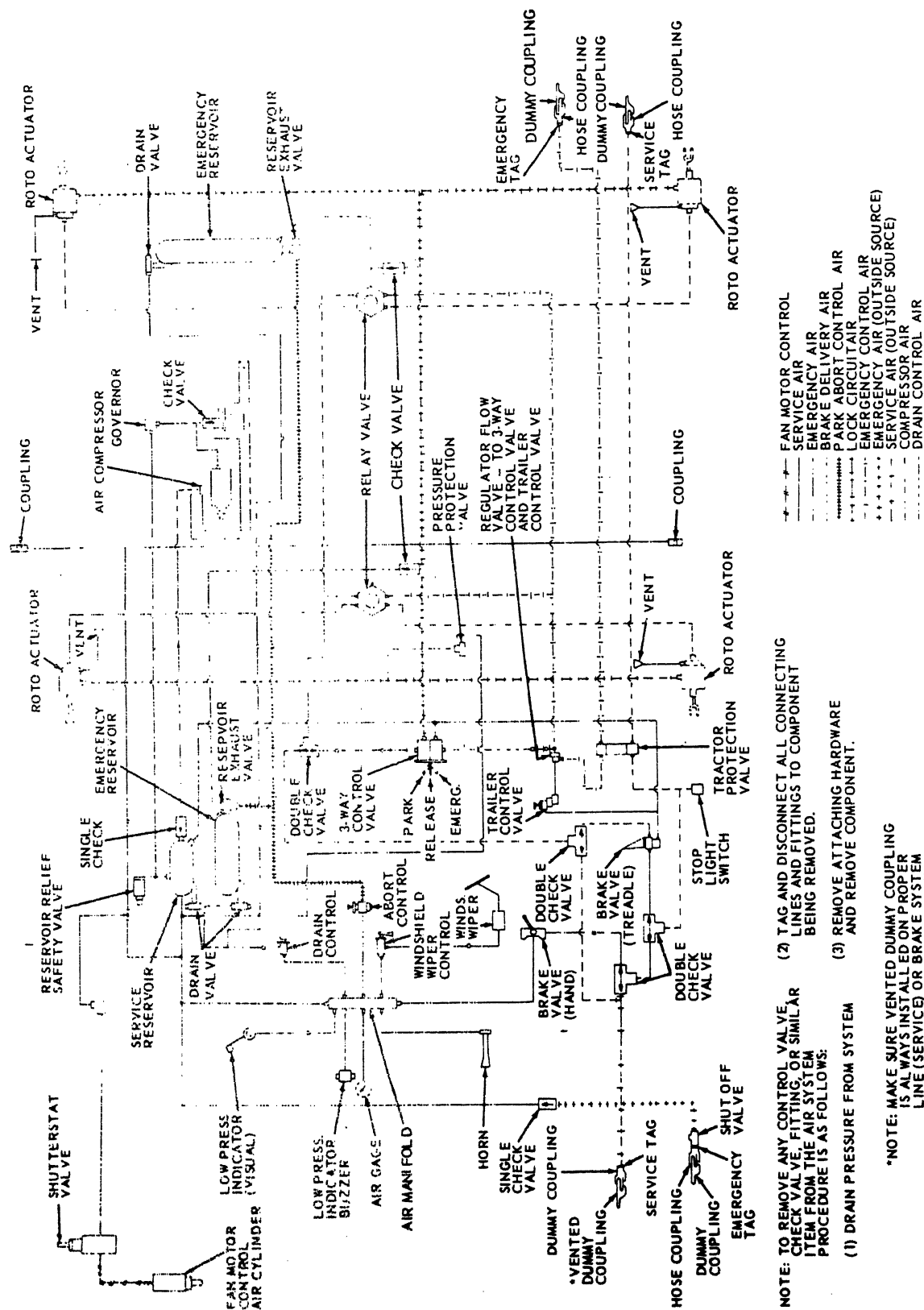
CARRIER AIR BRAKE SYSTEM

Section I. GENERAL

18-1. General

a. The carrier is equipped with service brakes on each wheel controlled by the air brake system. The service brakes are set by power of compressed air. The air

system consists of the air compressor, valves, reservoir, brake chambers connecting hoses, tubes and fittings (fig. 18-1).



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Figure 18-1. Air brake system.

- b. Refer to TM 5-3810-295-12 and figure 18-1 to remove air brake system components.

Section II. REPAIR OF BRAKE CHAMBER

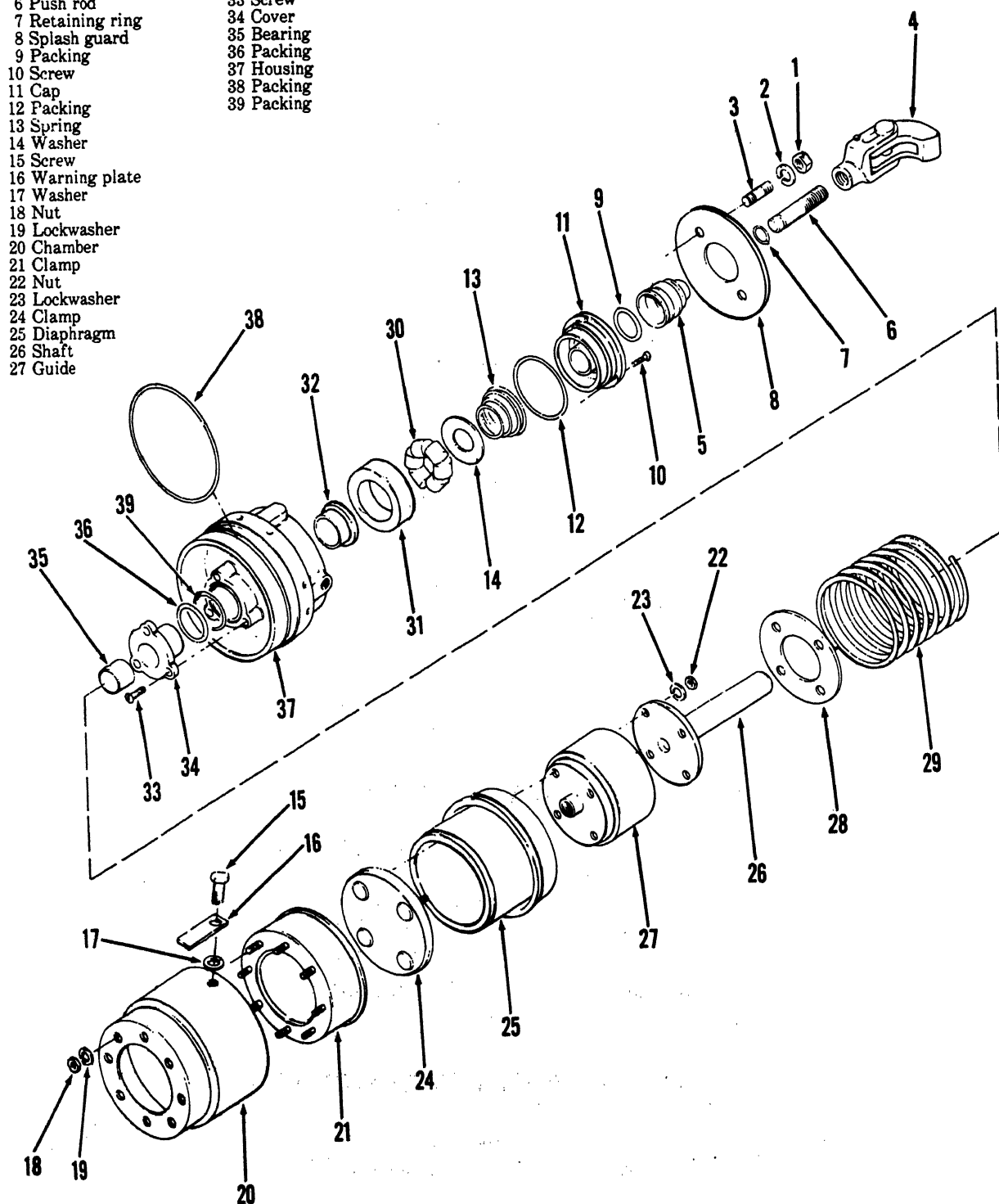
18-2. Removal and Disassembly

- a. Refer to TM 5-3810-295-12 and remove the brake chamber.
- b. Refer to figure 18-2 and disassemble the brake

chamber as described.

- (1) Remove nuts (1, fig. 18-2), lockwashers (2) and studs (3) and remove yoke assembly (4) from the brake chamber.

- | | |
|------------------|------------|
| 1 Nut | 28 Seat |
| 2 Lockwasher | 29 Spring |
| 3 Stud | 30 Roller |
| 4 Yoke | 31 Collar |
| 5 Boot | 32 Piston |
| 6 Push rod | 33 Screw |
| 7 Retaining ring | 34 Cover |
| 8 Splash guard | 35 Bearing |
| 9 Packing | 36 Packing |
| 10 Screw | 37 Housing |
| 11 Cap | 38 Packing |
| 12 Packing | 39 Packing |
| 13 Spring | |
| 14 Washer | |
| 15 Screw | |
| 16 Warning plate | |
| 17 Washer | |
| 18 Nut | |
| 19 Lockwasher | |
| 20 Chamber | |
| 21 Clamp | |
| 22 Nut | |
| 23 Lockwasher | |
| 24 Clamp | |
| 25 Diaphragm | |
| 26 Shaft | |
| 27 Guide | |



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Figure 18-2. Brake air chamber assembly—exploded view.

- (2) Remove boot (5), push rod (6), retaining ring (7) and splash guard (8).
- (3) Remove packing (9) from cap (11).
- (4) Remove screws (10) and pull cap (11) from housing (37). Remove packing (12) from cap (11).
- (5) Remove spring (13) and washer (14) from cap (11).
- (6) Remove screw (15), warning plate (16) and washer (17) from chamber body (20).
- (7) Remove nuts (18) and lockwashers (19) and remove body (20).
- (8) Remove outer clamp (21). Remove nuts (22) and lockwashers (23) and inner clamp (24) from diaphragm (25).
- (9) Lift diaphragm (25) and guide (27) from shaft (26).
- (10) Remove shaft (26) being careful to remove seat (28) and spring (29) without damage.
- (11) Remove roller (30), collar (31) and piston (32) from housing (37).
- (12) Remove screws (33), and remove cover (34) from housing (37).
- (13) If bearing (35) is damaged remove from cover (34).
- (14) Remove packing (36, 38 and 39) from housing (37).

18-3. Cleaning, Inspection and Repair

- a. Clean all metal parts with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly with compressed air.
- b. Inspect all parts for cracks, breaks, excessive wear or other damage. Repair or replace all defective

parts as necessary.

- c. Replace all packing with new.

18-4. Reassembly and Installation

- a. Refer to figure 18-2 and reassemble the brake chamber as follows:

- (1) Install new packing (36, 38 and 39) in housing (37).
 - (2) Install new bearing (35) in cover (34) if bearing is defective.
 - (3) Place cover (34) on housing (37) and secure with screws (33).
 - (4) Assemble shaft assembly by installing guide (27), diaphragm (25) and inner clamp (24) on shaft (26). Secure with lockwashers (23) and nuts (22).
 - (5) Install spring (29), seat (28) and shaft assembly (26) to housing (37) and install outer clamp (21).
 - (6) Install piston (32), collar (31) and roller (30) on shaft (26).
 - (7) Install chamber body (20) and secure with lockwashers (19) and nuts (18).
 - (8) Install lockwashers (17), and warning plate (16) and secure with screws (15).
 - (9) Install washer (14), spring (13), packing (12) and cap (11) on housing (37). Secure with screws (10). Install packing (9) on cap (11).
 - (10) Install retaining ring (7) on push rod (6) and install push rod into yoke (4).
 - (11) Install splash guard (8) and boot (5) and secure with studs (3), lockwashers (2) and nuts (1).
- b. Refer to TM 5-3810-295-12 and reinstall brake air chamber assembly in the air system.

Section III. REPAIR OF AIR TANKS

18-5. Removal and Disassembly

- a. Remove air tanks as instructed in paragraph 18-1.
- b. There is no additional disassembly of the air tanks other than fitting and line removal.

18-6. Cleaning, Inspection and Repair

- a. Clean the air tanks with cleaning solvent (Fed.

Spec. P-D-680 or equivalent) and dry thoroughly.

- b. Inspect tanks for cracks, breaks, dents or other damage. Repair or replace defective tanks.

- c. Inspect all fittings and mounting hardware for stripped or damaged threads. Replace as necessary.

18-7. Installation

Install the air tanks in reverse order of removal.

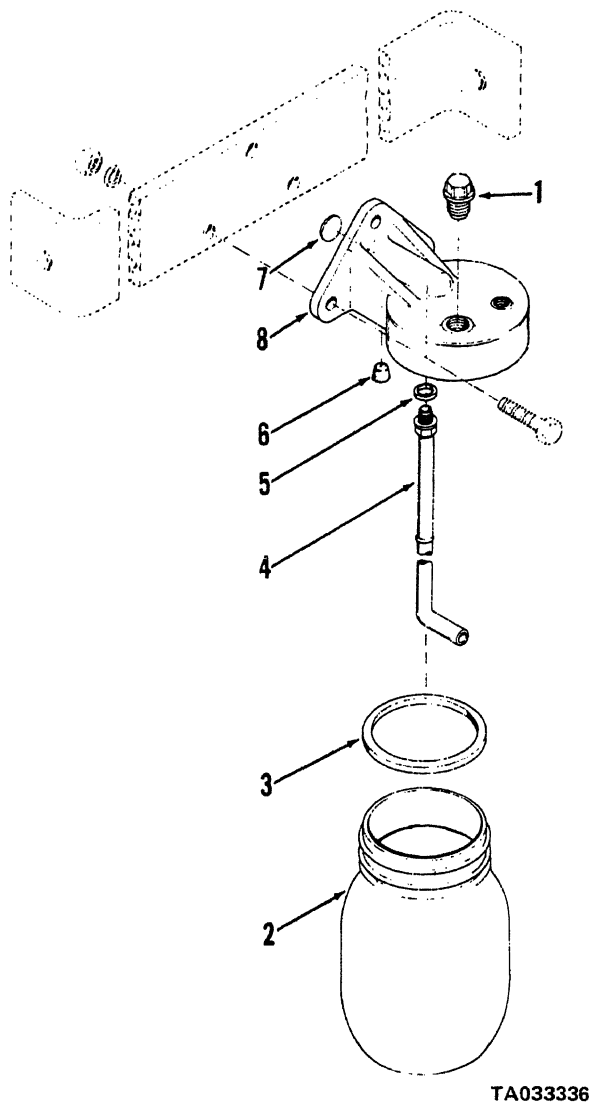
Section IV. REPAIR OF ALCOHOL EVAPORATOR ASSEMBLY

18-8. Removal and Disassembly

- a. Refer to TM 5-3810-295-12 and remove the alcohol evaporator assembly from the air brake system.
- b. Refer to figure 18-3 and disassemble the evapora-

tor as described below.

- (1) Remove filler plug (1) from evaporator body (8).



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- | | |
|---------------|-------------------|
| 1 Filler plug | 5 Washer |
| 2 Reservoir | 6 Air filter |
| 3 Gasket | 7 Expansion plug |
| 4 Tube | 8 Evaporator body |

Figure 18-3. Alcohol evaporator assembly—exploded view.

(2) Unscrew reservoir (2) from body (8) and remove gasket (3) and reservoir (2).

(3) Remove tube (4) and washer (5). Remove air filter (6) and expansion plug (7) from body (8).

18-9. Cleaning, Inspection and Repair

a. Clean all metal parts of the evaporator assembly with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly.

b. Inspect all parts for cracks, breaks or other damage. Replace or repair as necessary.

c. Inspect all hardware and fittings for stripped or damaged threads. Replace as necessary.

18-10. Reassembly and Installation

a. Refer to figure 18-3 and reassemble the evaporator assembly as follows:

(1) Install expansion plug (7), air filter (6) and filler plug (1) in evaporator body (8).

(2) Place washer (5) in body and install tube (4).

(3) Install new gasket (3) and install reservoir (2) on evaporator body (8).

b. Refer to TM 5-3810-295-12 and reinstall the alcohol evaporator assembly in reverse order of removal.

Section V. REPAIR OF GOVERNOR ASSEMBLY

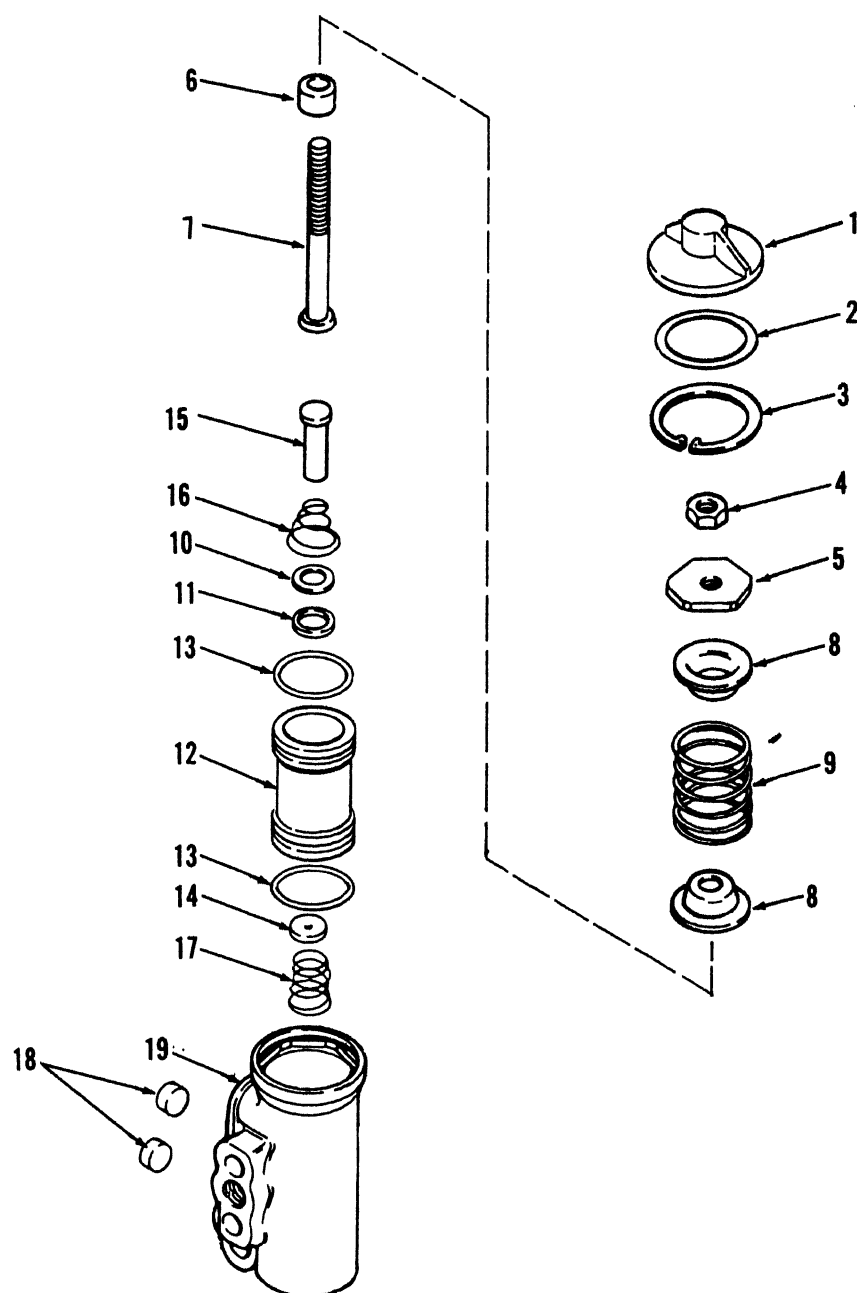
18-11. Removal and Disassembly

a. Remove governor assembly as instructed in paragraph 18-1.

b. Refer to figure 18-4 and disassemble the governor

assembly as follows:

(1) Remove cover (1) and grommet (2) from governor body (19).



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- 1 Cover
- 2 Grommet
- 3 Retaining ring
- 4 Nut
- 5 Spring seat
- 6 Spring guide
- 7 Screw
- 8 Spring seat
- 9 Spring
- 10 Washer

- 11 Grommet
- 12 Piston
- 13 Packing
- 14 Piston valve
- 15 Exhaust stem
- 16 Spring
- 17 Spring
- 18 Filter
- 19 Governor body

Figure 18-4. Governor assembly—exploded view.

(2) Remove retaining ring (3) and lift spring assembly from valve.

(3) Remove nut (4), spring seat (5), spring (9),

spring seats (8), spring guide (6) and screw (7).

(4) Remove exhaust stem (15), spring (16), washer (10) and grommet (11).

(5) Lift piston (12) from valve body (19) and remove packing (13).

(6) Remove piston valve (14) and spring (17) from piston (12).

(7) Remove filters (18) from valve body (19).

18-12. Cleaning, Inspection and Repair

a. Clean all metal parts of the governor assembly with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly.

b. Inspect all parts for cracks, breaks, excessive wear or other damage. Repair or replace as necessary.

c. Inspect all fittings and hardware for stripped or damaged threads. Replace as necessary.

18-13. Reassembly and Installation

a. Refer to figure 18-4 and reassemble the governor

assembly as follows:

(1) Install the filters (18) into valve body (19).

(2) Install new packing (13) on piston (12) and place piston valve (14) and spring (17) in piston (12). Install the piston in valve body (19).

(3) Install grommet (11), washer (10), spring (16) and exhaust stem (15) into piston (12).

(4) Install spring seat (8), guide (6), spring (9) and spring seat (5) on screw (7) and secure with nut (4).

(5) Install spring assembly into valve and secure with retaining ring (3).

(6) Install grommet (2) and cover (1) on valve body (19).

b. Refer to paragraph 18-1 and install the governor assembly in reverse order of removal.

Section VI. REPAIR OF AIR PRESSURE INDICATOR ASSEMBLY

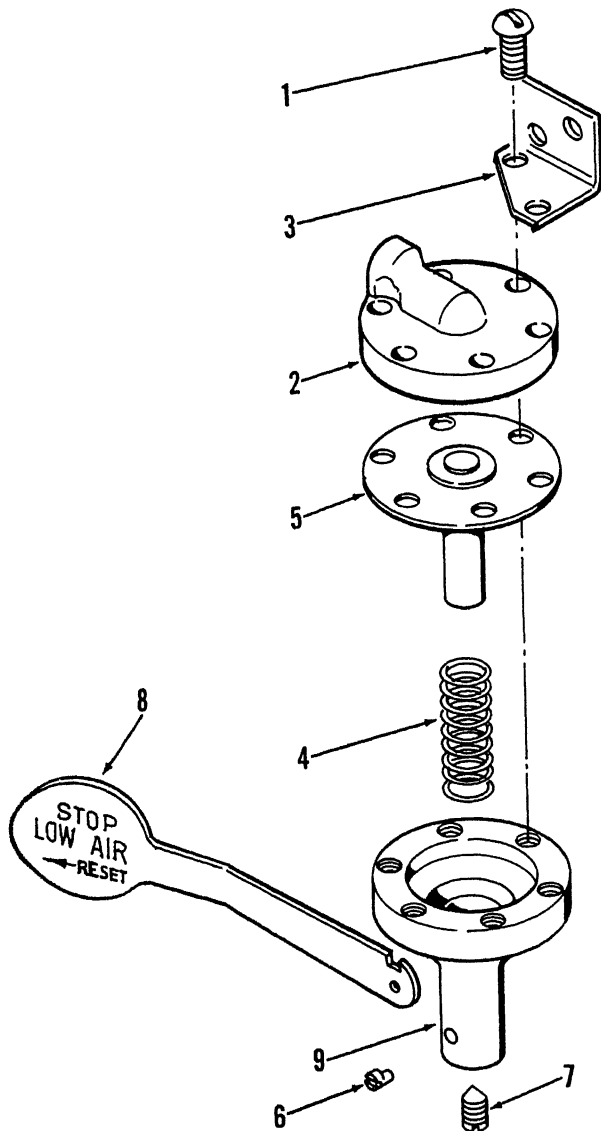
18-14. Removal and Disassembly

a. Refer to figure 18-1 and remove the air pressure indicator assembly as instructed.

b. Refer to figure 18-5 and disassemble the pressure

indicator as follows:

(1) Remove screws (1) and remove mounting bracket (3) from upper housing (2).



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- | | |
|-----------------|-----------------|
| 1 Screw | 6 Setscrew |
| 2 Upper housing | 7 Stud |
| 3 Bracket | 8 Plate |
| 4 Spring | 9 Lower housing |
| 5 Diaphragm | |

Figure 18-5. Air pressure indicator—exploded view.

(2) Separate upper housing (2) from lower housing (9) and remove spring (4) and diaphragm (5).

(3) Remove set screw (6) and stud (7) and remove plate (8) from lower housing (9).

18-15. Cleaning, Inspection and Repair

a. Clean all metal parts of the pressure indicator assembly with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly.

b. Inspect all parts for cracks, breaks, excessive wear or other damage. Repair or replace as required.

c. Inspect all fittings and hardware for stripped or damaged threads and replace as necessary.

18-16. Reassembly and Installation

a. Refer to figure 18-5 and reassemble the pressure indicator assembly as follows:

(1) Install plate (8) into lower housing and secure with setscrew (6) and stud (7).

(2) Install spring (4) and diaphragm (5) into lower housing and assemble lower housing (9) to upper housing (2). Secure upper housing (2) and lower housing (9) with screws (1).

(3) Install bracket (3) under two of the mounting screws (1).

b. Refer to figure 18-1 and install the pressure indicator assembly in reverse order of removal.

Section VII. REPAIR OF AIR VALVE ASSEMBLIES

18-17. Treadle Valve Assembly

a. Removal and Disassembly.

(1) Refer to TM 5-3810-295-12 and remove the treadle valve from the air brake system.

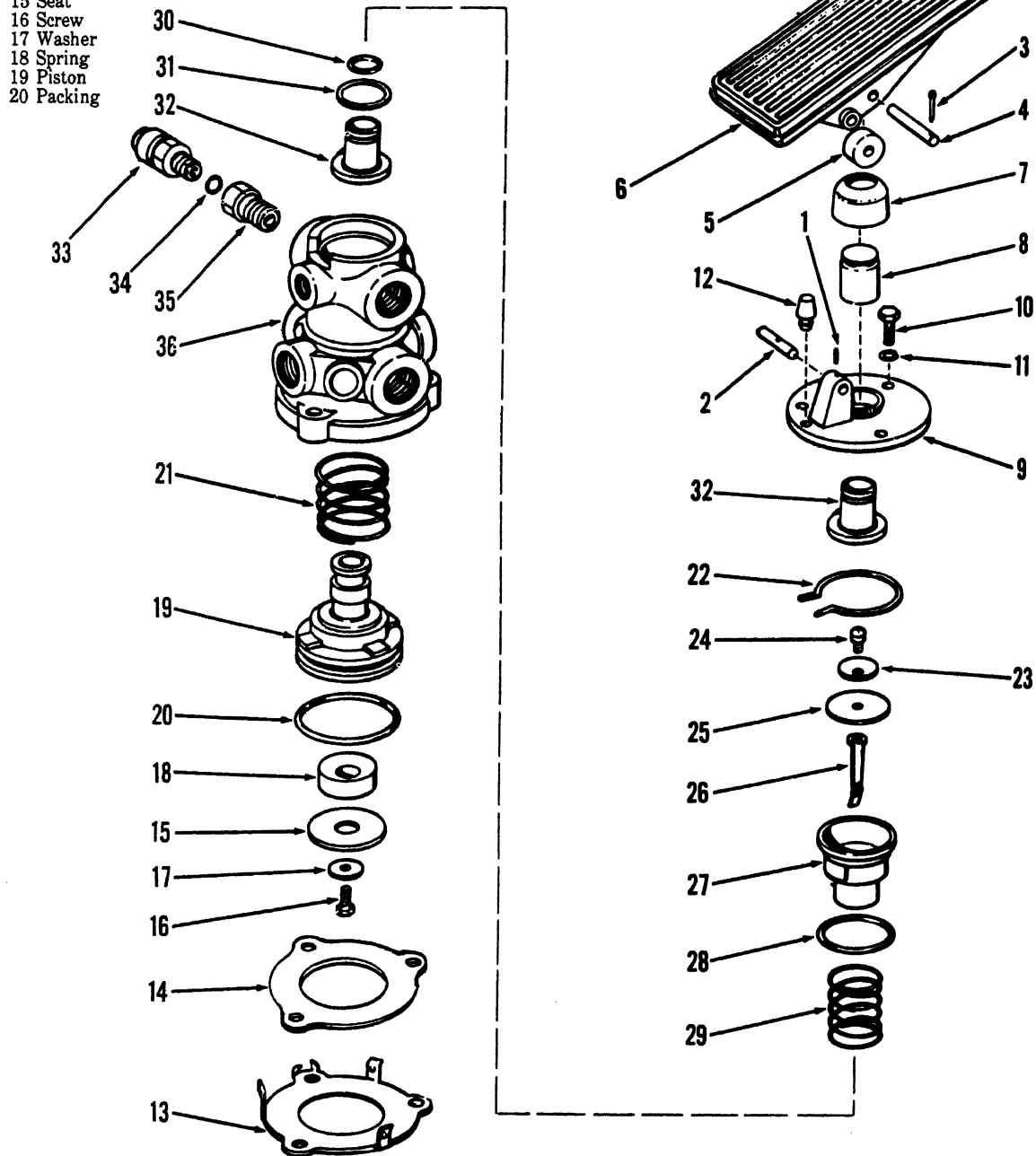
(2) Refer to figure 18-6 and disassemble the treadle valve assembly as described below.

dle valve assembly as described below.

(a) Remove roll pin (1) and pin (2) from pedal mounting assembly.

(b) Remove cotter pin (3) and pin (4) and lift pedal assembly off.

- | | | |
|------------------|-------------------|-------------|
| 1 Roll pin | 21 Spring | 29 Spring |
| 2 Straight pin | 22 Retaining ring | 30 Retainer |
| 3 Cotter pin | 23 Clinch washer | 31 Packing |
| 4 Straight pin | 24 Screw | 32 Valve |
| 5 Roller | 25 Diaphragm | 33 Valve |
| 6 Pedal | 26 Spring | 34 Packing |
| 7 Boot | 27 Seat | 35 Plug |
| 8 Detent plunger | 28 Packing | 36 Body |
| 9 Mounting plate | | |
| 10 Screw | | |
| 11 Lockwasher | | |
| 12 Stop button | | |
| 13 Retainer | | |
| 14 Gasket | | |
| 15 Seat | | |
| 16 Screw | | |
| 17 Washer | | |
| 18 Spring | | |
| 19 Piston | | |
| 20 Packing | | |



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Figure 18-6. Brake treadle valve assembly—exploded view.

- (c) Remove roller (5) from pedal assembly (6).
- (d) Remove boot (7) and detent plunger (8) from mounting plate (9).
- (e) Remove screws (10), and lockwashers (11) and lift mounting plate (9) from carrier. Remove stop button (12) from the mounting plate.
- (f) Remove retainer (13) and gasket (14) from valve body (36). Discard gasket.
- (g) Remove screw (16), seat (15) washer (17) and spring (18) from the valve assembly.
- (h) Remove piston (19) from valve body (36) and remove packing (20) and spring (21) from the piston assembly. Discard packing.
- (i) Remove retaining ring (22) and remove screw (24) and clinch washer (23).
- (j) Remove spring (26) and seat (27). Remove packing (28) from the seat and discard packing.
- (k) Remove spring (29), retainer (30) and valve (32). Remove packing (31) and discard.
- (l) Remove valve (33), packing (34) and plug (35) from valve body (36). Discard packing.

b. Cleaning, Inspection and Repair.

- (1) Clean all metal parts of the valve assembly with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly with compressed air.
- (2) Discard all preformed packing and replace with new in reassembly.
- (3) Inspect all parts for cracks, breaks or excessive wear. Repair or replace as necessary.
- (4) Inspect all fittings and mounting hardware for stripped or damaged threads. Replace as necessary.

c. Reassembly and Installation.

- (1) Refer to figure 18-6 and reassemble the brake treadle valve assembly as follows:
 - (a) Install plug (35) in valve body (36). Place

new packing (34) in plug and install valve (33).

- (b) Install valve (32), packing (31) and retainer (30) in valve body (36).

- (c) Install new packing (28) on seat (27) and install spring (29) and seat (27) in valve body (36) secure with retaining ring (22).

- (d) Install spring (26), diaphragm (25) and clinch washer (23). Secure with screw (24).

- (e) Install new packing (20) on piston (19) and install spring (21) and piston (19) in valve body (36).

- (f) Install spring (18), seat (15), and washer (17). Secure with screw (16).

- (g) Install new gasket (14) and retainer (13) on valve body (36).

- (h) Install stop button (12) on mounting plate and reinstall plate (9). Secure with lock washers (11) and screws (10).

- (i) Install detent plunger (8) and boot (7) to mounting plate.

- (j) Install roller (5) to pedal (6) and install pedal assembly to mounting plate with pins (4 and 2), cotter pin (3) and roll pin (1).

- (2) Refer to TM 5-3810-295-12 and reinstall the treadle valve assembly in the brake air system in reverse order of removal.

18-18. Brake Actuating Valve

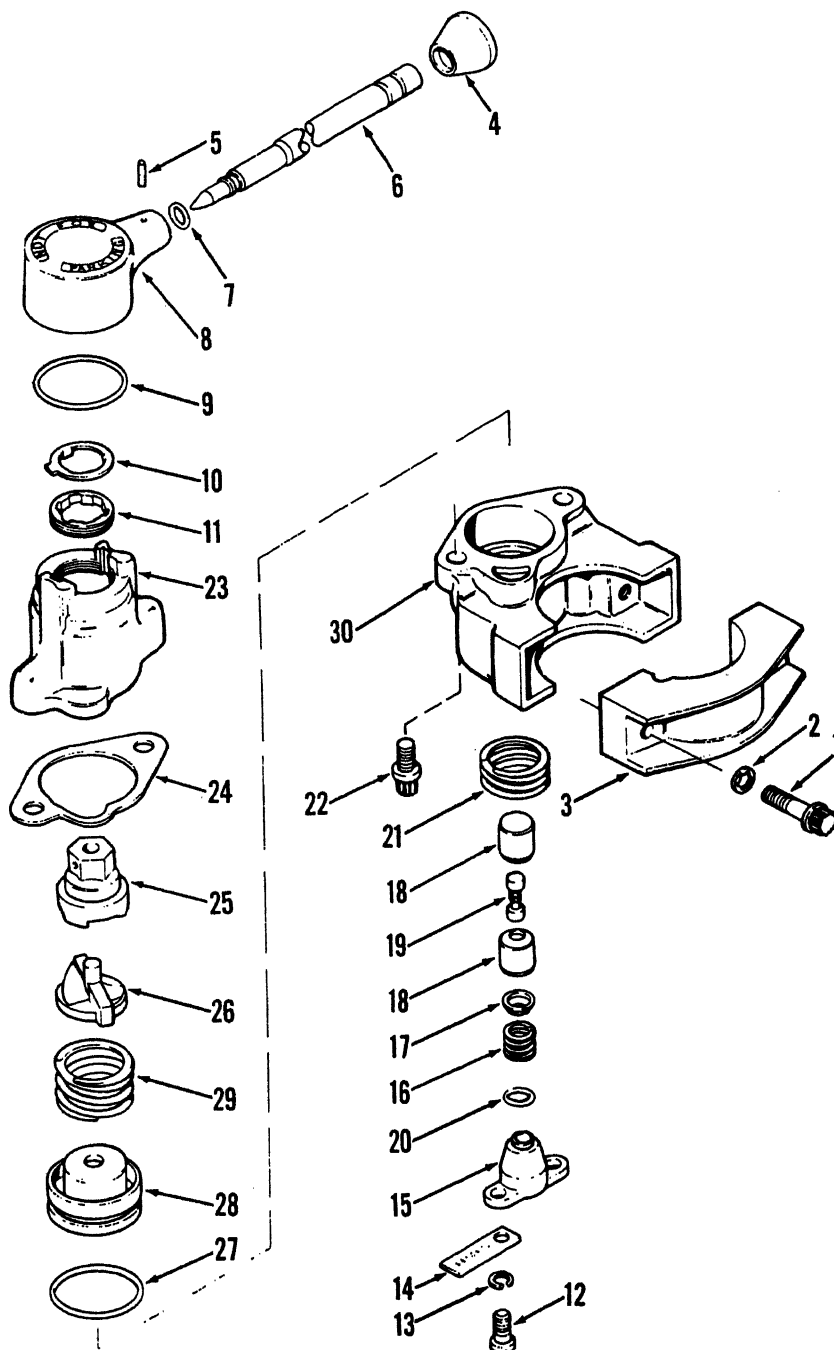
a. Removal and Disassembly.

- (1) Refer to TM 5-3810-295-12 and remove the brake actuating valve.

- (2) Refer to figure 18-7 and disassemble the actuating valve as described below.

- (a) Remove screws (1) and lockwashers (2) and remove clamp (3).

- 1 Screw
- 2 Lockwasher
- 3 Clamp
- 4 Handle knob
- 5 Spring pin
- 6 Handle
- 7 Packing
- 8 Handle head
- 9 Packing
- 10 Key washer
- 11 Adjusting ring
- 12 Screw
- 13 Lockwasher
- 14 Plate
- 15 Valve seat
- 16 Spring
- 17 Valve guide
- 18 Piston valve
- 19 Needle stem
- 20 Packing
- 21 Spring
- 22 Screw
- 23 Valve cover
- 24 Gasket
- 25 Cam follower
- 26 Cam handle
- 27 Packing
- 28 Piston
- 29 Spring
- 30 Body



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Brake actuating valve—exploded view.

- (b) Unscrew handle knob (4) from handle (6).
- (c) Remove spring pin (5) and remove handle (6). Remove and discard packing (7).
- (d) Remove handle head (8) from valve cover (23) and remove packing (9) and key washer (10).
- (e) Remove adjusting ring (11) taking note of the number of turns ring was in valve cover.
- (f) Remove screws (12) and lockwashers (13) and remove plate (14), valve seat (15), spring (16), valve guide (17), piston valve (18) and needle stem (19).
- (g) Remove packing (20) from valve seat (15) and discard.
- (h) Remove spring (21) from valve body (30).
- (i) Remove screws (22) and separate valve cover (23) from valve body (30). Remove gasket (24), cam follower (25), cam handle (26), spring (29) and piston (28) from valve body (30).
- (j) Remove and discard packing (27) from piston (28).

b. Cleaning, Inspection and Repair.

(1) Clean all metal parts of the actuating valve assembly with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly.

(2) Inspect all parts of the valve for cracks, breaks or excessive wear. Repair or replace as necessary.

(3) Inspect all fittings and hardware for stripped or damaged threads. Replace as necessary.

c. Reassembly and Installation.

(1) Refer to figure 18-7 and reassemble the actuating valve as follows:

- (a) Install new packing (27) on valve piston (28).
 - (b) Install piston (28), spring (29), cam handle (26) and cam follower (25) in valve body (30).
 - (c) Place new gasket (24) on valve body and install cover (23). Secure with screws (22).
 - (d) Install spring (21), needle stem (19), piston valve (18), valve guide (17) and spring (16) into valve body (30).
 - (e) Install new packing (20) on valve seat (15) and install the seat into valve body (30). Secure with plate (14), lockwashers (13) and screws (12).
 - (f) Install adjusting ring (11) into cover (23) the same number of turns noted in removal.
 - (g) Install key washer (10), new packing (9) and handle head (8) on valve cover (23).
 - (h) Place new packing (7) on handle and push handle into handle head (8). Secure with spring pin (5).
 - (i) Install handle knob (4) on handle (6).
 - (j) Install clamp (3) to valve body (30) and secure with lockwashers (2) and screws (1).
- (2) Refer to TM 5-3810-295-12 and reinstall the actuating valve assembly.

18-19. Check Valves

a. Removal and Disassembly.

(1) Refer to TM 5-3810-295-12 and remove the check valve as instructed.

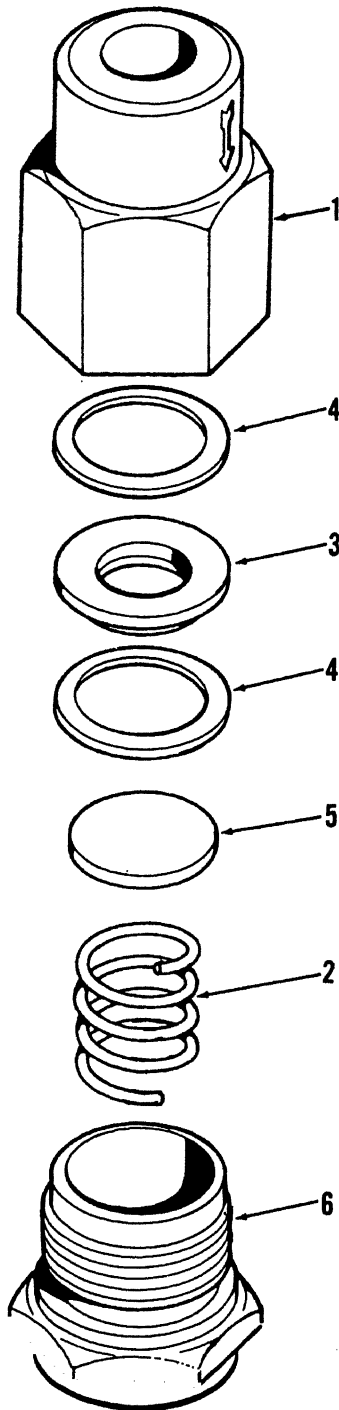
(2) Refer to figure 18-8 and disassemble the single check valve as follows:

- (a) Unscrew the cap nut (1, fig. 18-8) from valve body (6).

(b) Remove spring (2), valve seat (5), washers (4) and discharge valve (3) from valve body (6).

(3) Refer to figure 18-9 and disassemble the double check valve assembly as follows:

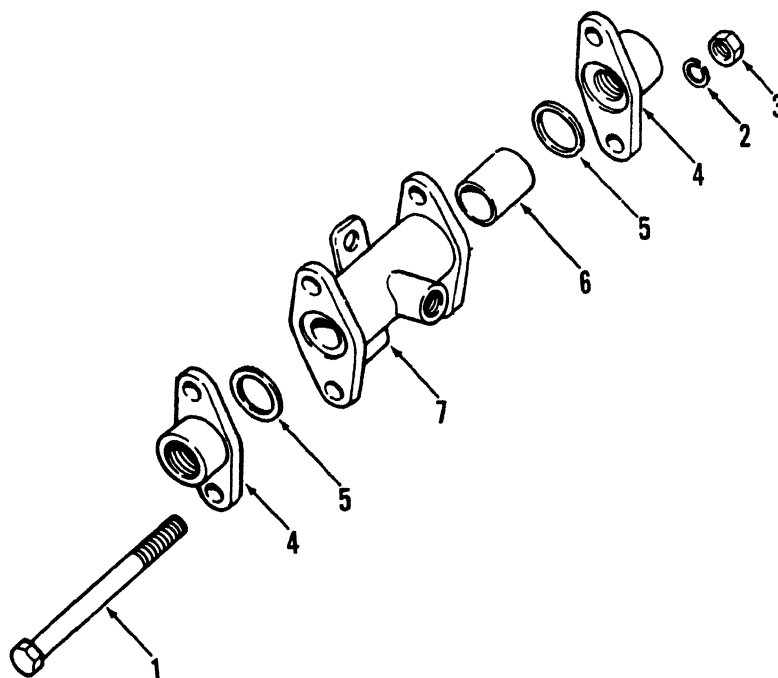
(a) Remove screws (1, fig. 18-9) lockwashers (2) and nuts (3) and remove cap nuts (4).



- 1 Cap nut
- 2 Spring
- 3 Discharge valve
- 4 Washer
- 5 Valve seat
- 6 Valve body

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Figure 18-8. Single check valve assembly—exploded view.



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- 1 Screw
- 2 Lockwasher
- 3 Nut
- 4 Cap nut
- 5 Packing
- 6 Shuttle valve
- 7 Valve body

Figure 18-9. Double check valve—exploded view.

(b) Remove packing (5) and shuttle valve (6) from valve body (7).

b. Cleaning, Inspection and Repair.

(1) Clean all metal parts of the check valves with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly.

(2) Inspect all parts for cracks, breaks or other damage. Replace or repair as necessary.

(3) Inspect all fittings and mounting hardware for stripped or damaged threads and replace as necessary.

c. Reassembly and Installation.

(1) Refer to figure 18-8 and reassemble the single check valve as follows:

(a) Install spring (2), valve seat (5), washers (4) and discharge valve (3) into valve body (6).

(b) Screw cap nut (1) on valve body (6).

(2) Refer to figure 18-9 and reassemble the double check valve as follows:

(a) Install new packing (5) in cap nuts (4) and install shuttle valve (6) into valve body (7).

(b) Place cap nuts (4) on body (7) and secure with nuts (3), lockwashers (2) and screws (1).

(3) Refer to TM 5-3810-295-12 and reinstall the check valve assemblies.

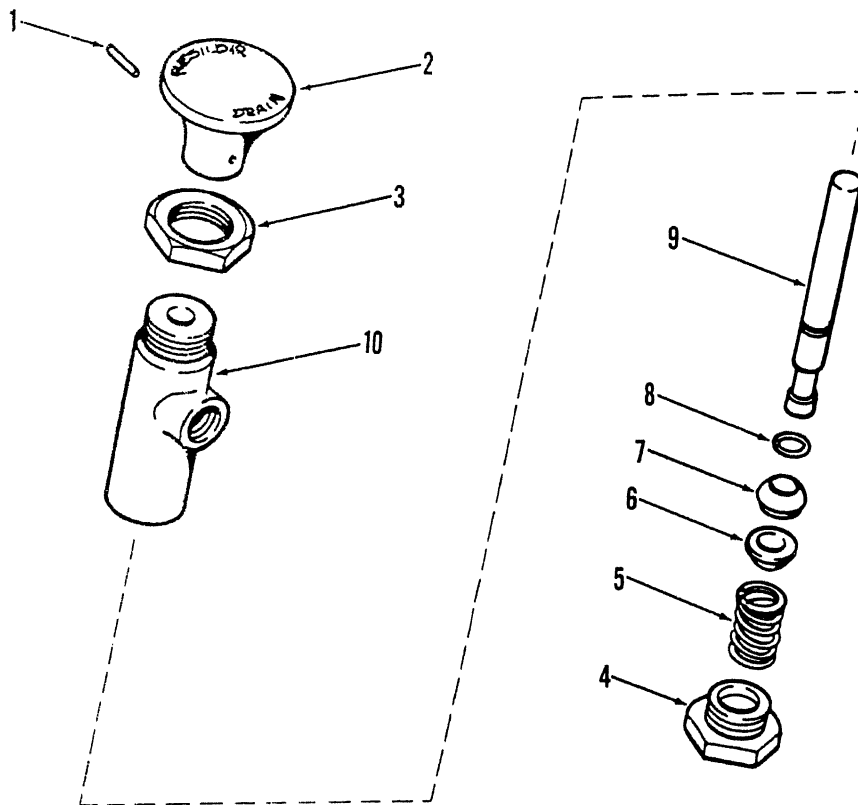
18-20. Drain Valve Assembly

a. Removal and Disassembly.

(1) Remove the drain valve assembly per instructions in TM 5-3810-295-12.

(2) Refer to figure 18-10 and disassemble the drain valve assembly as follows:

(a) Remove spring pin (1) and lift valve button (2) from valve assembly.



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- 1 Spring pin
- 2 Valve button
- 3 Nut
- 4 Nut
- 5 Spring
- 6 Spring seat
- 7 Inlet valve
- 8 Packing
- 9 Needle stem
- 10 Valve body

Figure 18-10. Drain valve assembly—exploded view.

- (b) Remove nut (3) from valve body (10).
- (c) Remove nut (4), spring (5), spring seat (6), inlet valve (7) and needle stem (9) from valve body (10).
- (d) Remove and discard packing (8) from needle

(b) Install needle stem (9), inlet valve (7), spring seat (6) and spring (5). Holding spring in place secure with nut (4).

(c) Install nut (3) to valve body (10).

(d) Install valve button (2) and secure with spring pin (1).

(2) Refer to TM 5-3810-295-12 and install the drain valve assembly.

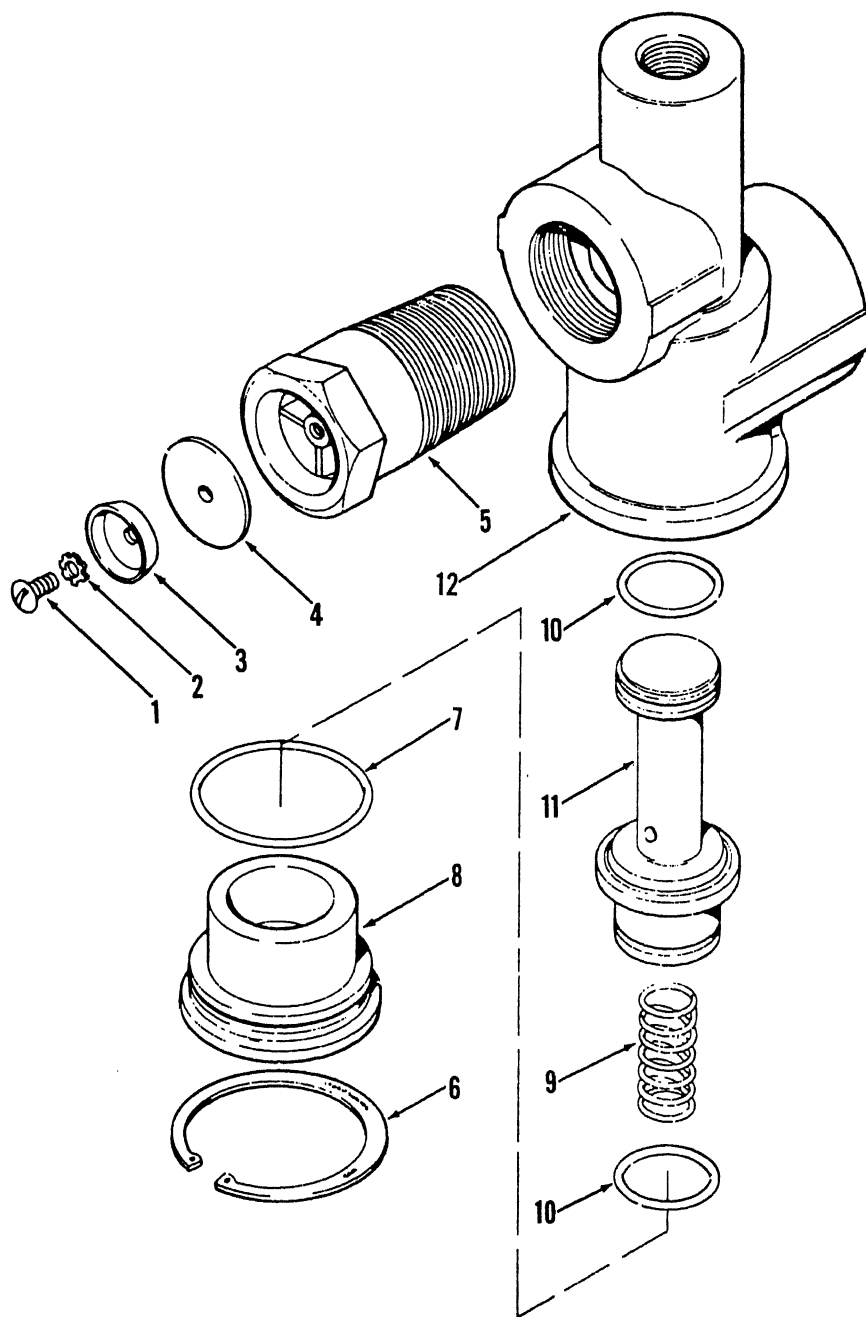
18-21. Reservoir Exhaust Control Valve

a. Removal and Disassembly.

(1) Refer to figure 18-1 and remove the reservoir exhaust control valve as instructed.

(2) Refer to figure 18-11 and disassemble the reservoir exhaust control valve as follows:

(a) Remove screw (1), lockwashers (2), washer (3) and diaphragm (4) from check valve body (5).



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- 1 Screw
- 2 Lockwasher
- 3 Shoulder washer
- 4 Diaphragm
- 5 Check valve body
- 6 Retaining ring
- 7 Packing
- 8 Retaining guide
- 9 Spring
- 10 Packing
- 11 Control valve
- 12 Control valve body

Figure 18-11. Reservoir exhaust control valve—exploded view.

(b) Remove check valve body (5) from the control valve body (12).

(c) Remove retaining ring (6) and retaining guide (8) from control valve body (12).

(d) Remove and discard packing (7) from retaining guide (8).

(e) Remove control valve (11) from control valve body (12).

(f) Remove and discard packing (10) from control valve (11).

b. Cleaning, Inspection and Repair.

(1) Clean all metal parts of the reservoir exhaust control valve with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly.

(2) Inspect all parts for cracks, breaks, excessive wear or other damage. Repair or replace as necessary.

(3) Inspect all fittings and hardware for stripped or damaged threads and replace as necessary.

c. Reassembly and Installation.

(1) Refer to figure 18-11 and reassemble the reservoir exhaust control valve as follows:

(a) Install new packing (10) on control valve (11).

(b) Install control valve (11) into valve body (12) and install spring (9).

(c) Install new packing (7) on retaining guide (8) and install guide into valve body (12). Secure with retaining ring (6).

(d) Install check valve body (5) in the control valve body (12).

(e) Install diaphragm (4) and shoulder washer (3). Secure with lockwasher (2) and screw (1).

(2) Refer to figure 18-1 and install the reservoir exhaust control valve in reverse order of removal.

18-22. Three Way Control Valve

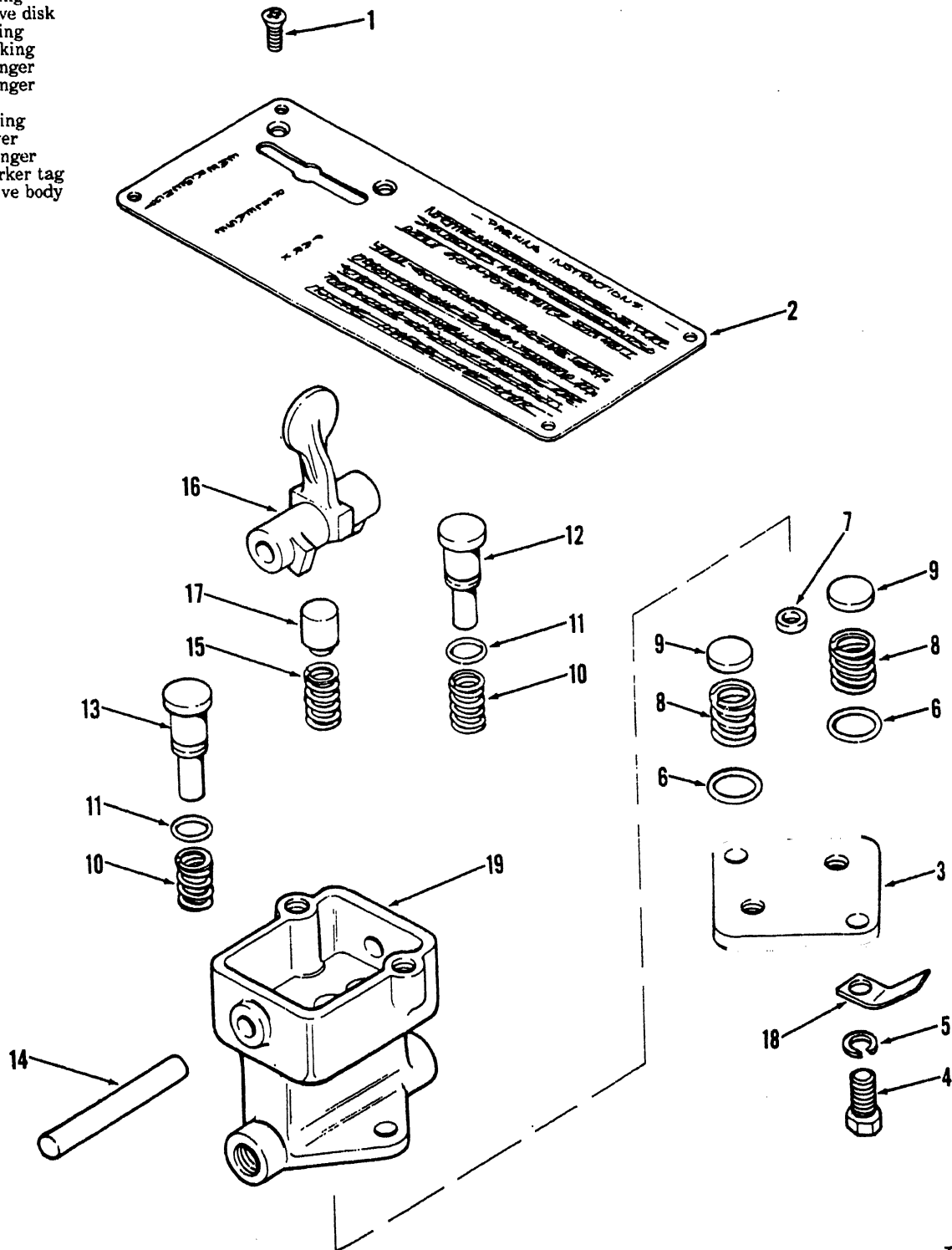
a. Removal and Disassembly.

(1) Refer to figure 18-1 and remove the three way control valve as instructed.

(2) Refer to figure 18-12 and disassemble the control valve as follows:

(a) Remove screws (1) and instruction plate (2).

- 1 Screw
- 2 Instruction plate
- 3 Inlet plate
- 4 Screw
- 5 Lockwasher
- 6 Packing
- 7 Spacer
- 8 Spring
- 9 Valve disk
- 10 Spring
- 11 Packing
- 12 Plunger
- 13 Plunger
- 14 Pin
- 15 Spring
- 16 Lever
- 17 Plunger
- 18 Marker tag
- 19 Valve body



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Figure 18-12. Three way control valve—exploded view.

(b) Remove inlet plate (3) by removing screws (4) and lockwashers (5). Remove marker tag (18).

(c) Remove and discard packing (6). Remove spacer (7), springs (8) and valve disks (9) from valve body (19).

(d) Remove pin (14) from valve body (19).

NOTE

Be sure to maintain pressure on lever (16) while removing pin (14).

(e) Slowly remove lever (16) and plungers (12 and 13). Remove springs (10).

(f) Remove and discard packing (11) from plungers (12 and 13).

(g) Remove plunger (17) and spring (15) from valve body (19).

b. Cleaning, Inspection and Repair.

(1) Clean all parts of the three way control valve with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly.

(2) Inspect all parts for cracks, breaks or excessive wear. Repair or replace as required.

(3) Inspect all fittings and hardware for stripped or damaged threads. Replace as necessary.

c. Reassembly and Installation.

(1) Refer to figure 18-12 and reassemble the three

way control valve as follows:

(a) Install spring (15) and plunger (17) into valve body (19).

(b) Install new packing (11) on plungers (12 and 13) and install spring (10) and plungers (12 and 13) into valve body (19).

(c) Holding plungers and springs install lever (16) into valve body and secure with pin (14).

(d) Install valve discs (9), springs (8) and spacer (7) into valve body.

(e) Install new packing (6) and install inlet plate (3). Secure lockwashers (5) and screws (4). Install marker tag (18) under screw (4) and lockwasher (5).

(f) Install instruction plate (2) and secure with screws (1).

(2) Refer to figure 18-1 and install the three way control valve.

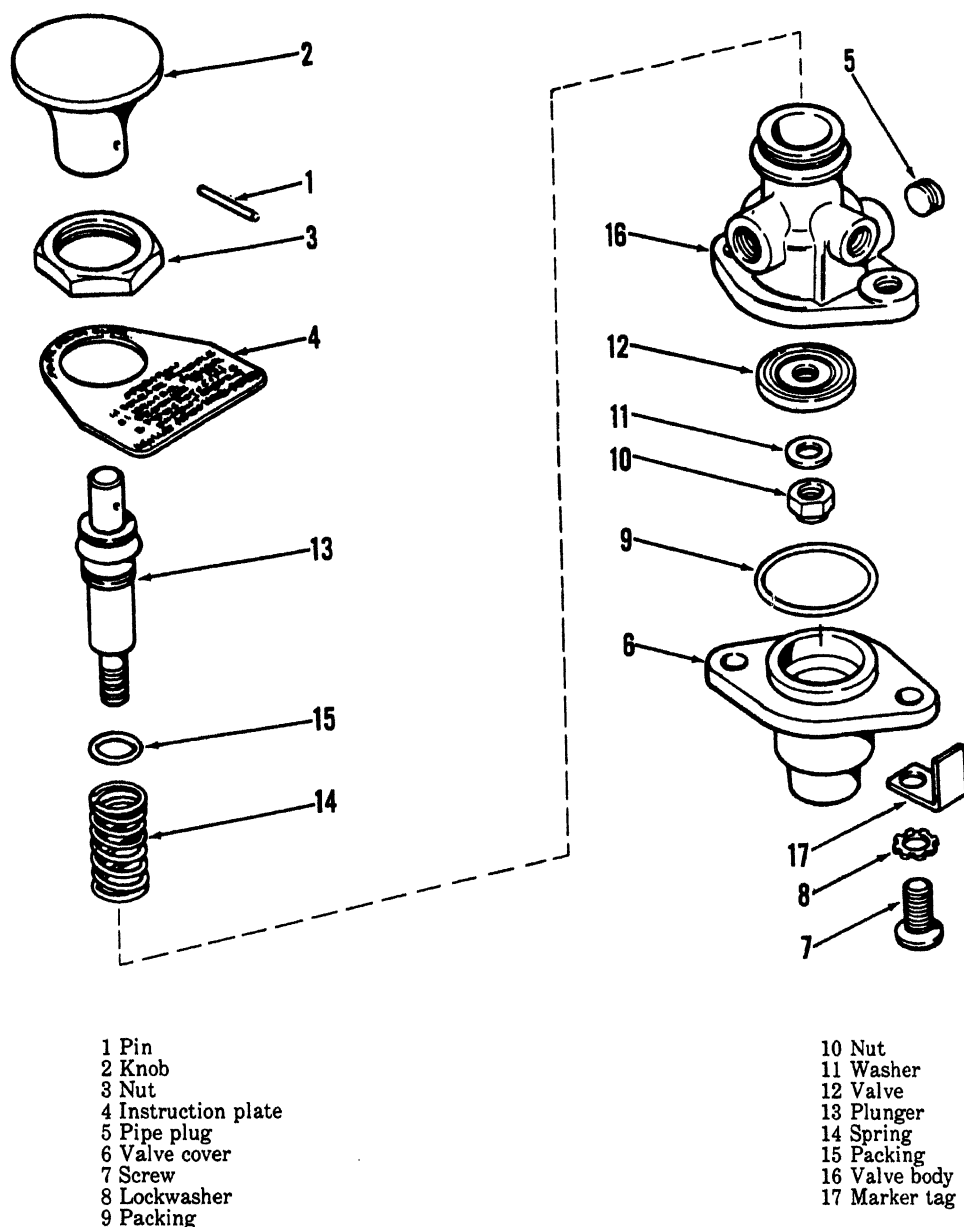
18-23. Park Release Control Valve

a. Removal and Disassemble.

(1) Refer to TM 5-3810-295-12 and remove the park release control valve as instructed.

(2) Refer to figure 18-13 and disassemble the park release control valve as follows:

(a) Remove pin (1) from knob (2) and remove the knob from plunger (13).



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Figure 18-13. Park release control valve—exploded view.

(b) Remove nut (3) and instruction plate (4) from plunger (13).

(c) Remove pipe plug (5) from valve body (16).

(d) Remove screws (7), lockwashers (8) and marker tag (17).

(e) Separate valve cover (6) from valve body (16) and remove packing (9) from cover.

(f) Remove nut (10), washer (11) and valve (12) from plunger (13) and remove plunger from valve body.

(g) Remove spring (14) and packing (15) from plunger (13).

b. Cleaning, Inspection and Repair.

(1) Clean all metal parts of the pack release control valve with cleaning solvent (Fed. Spec. P-D-680 or equivalent).

(2) Inspect all parts of the control valve for cracks, breaks, excessive wear or other damage. Repair or replace as necessary.

(3) Inspect all fittings and hardware for stripped or damaged threads. Replace as necessary.

c. Reassembly and Installation.

(1) Refer to figure 18-13 and reassemble the park release control valve as follows:

(a) Install new packing (15) on plunger (13). In-

stall plunger in valve body (16).

(b) Install spring (14), valve (12), washer (11) and nut (10) on plunger (13).

(c) Install new packing (9) on valve cover (6) and place cover on valve body (16). Secure with lockwashers (8) and screws (7).

(d) Install marker tag (17) with lockwasher (8) and screw (7).

(e) Install pipe plug (5) and instruction plate (4) to valve body (16).

(f) Install nut (3) and knob (2) and secure knob with pin (1).

(2) Refer to TM 5-3810-295-12 and install park

release control valve.

18-24. Drain Valve Assembly

a. Removal and Disassembly.

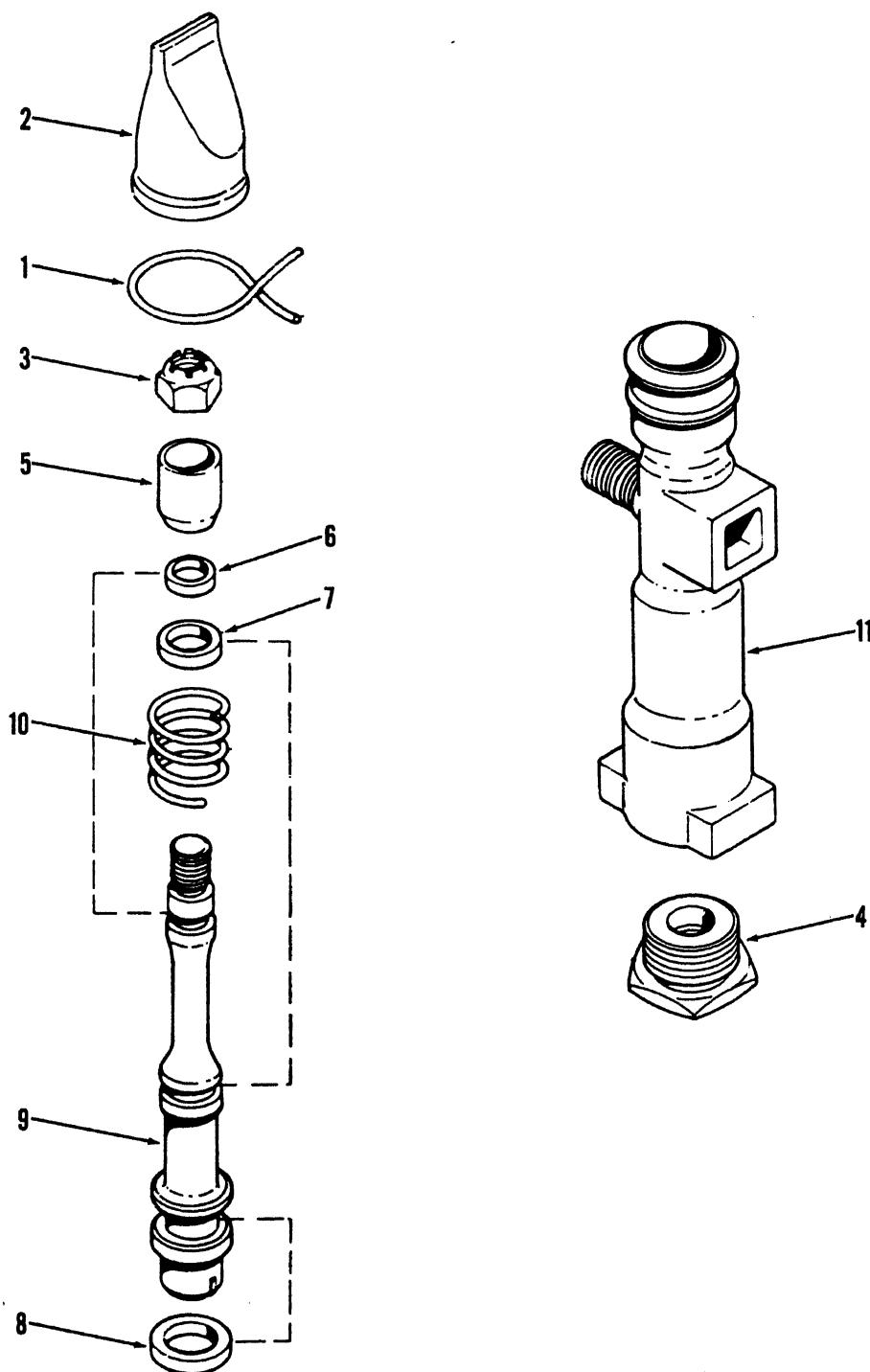
(1) Refer to figure 18-1 and remove the drain valve assembly as instructed.

(2) Refer to figure 18-14 and disassemble the drain valve as follows:

(a) Remove loop clamp (1) from dust boot (2) and remove boot from valve assembly.

(b) Remove nut (3) from valve plunger (9) and remove nut (4) from valve body (11).

(c) Remove valve (5) from plunger (9) and remove plunger from valve body (11).



- 1 Loop clamp
- 2 Dust boot
- 3 Nut
- 4 Nut
- 5 Valve
- 6 Packing

- 7 Packing
- 8 Packing
- 9 Plunger
- 10 Spring
- 11 Valve body

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Figure 18-14. Drain valve assembly—exploded view.

- (d) Remove spring (10) from plunger (9).
- (e) Remove and discard packing (6, 7 and 8) from plunger (9).

b. Cleaning, Inspection and Repair.

(1) Clean all metal parts of the drain valve assembly with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly.

(2) Inspect all parts of the valve assembly for cracks, breaks, excessive wear or other damage. Repair or replace as necessary.

(3) Inspect all fittings and hardware for stripped or damaged threads. Replace as necessary.

c. Reassembly and Installation.

(1) Refer to figure 18-14 and reassemble the drain valve assembly as follows:

(a) Install new packing (6, 7 and 8) on plunger (9).

(b) Install plunger (9) into valve body (11) and slide spring (10) and valve (5) on the plunger.

(c) Install nut (4) on valve body (11) and nut (3) on plunger (9).

(d) Install dust boot (2) and secure boot on valve body with loop clamp (1).

(2) Refer to figure 18-1 and install drain valve assembly in reverse order of removal.

18-25. Safety Valve Assembly

a. Removal and Disassembly.

(1) Refer to figure 18-1 and remove the safety valve assembly as instructed.

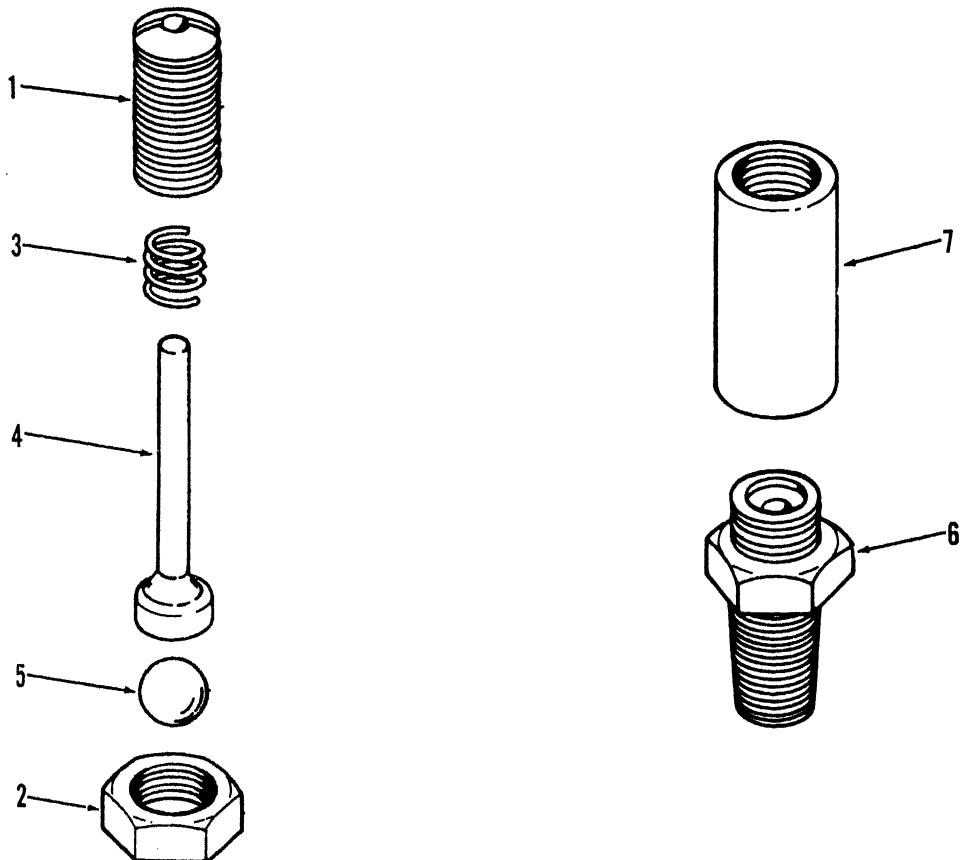
(2) Refer to figure 18-15 and disassemble the safety valve assembly as follows:

(a) Remove adjusting nut (1) from valve body (7).

NOTE

Take note of the number of turns required to remove adjusting nut.

(b) Remove lock nut (2) from adjusting nut (1).



- 1 Adjusting nut
- 2 Lock nut
- 3 Spring
- 4 Release pin

- 5 Check ball
- 6 Retainer
- 7 Valve body

Figure 18-15. Safety valve assembly—exploded view.

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(c) Remove spring (3), release pin (4) and check ball (5) from valve body (7).

(d) Remove retainer (6) from valve body.

b. Cleaning, Inspection and Repair.

(1) Clean all metal parts of the safety valve assembly with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly.

(2) Inspect all parts of the safety valve for cracks, breaks, excessive wear or other damage. Repair or replace as necessary.

(3) Inspect fittings and hardware for stripped or damaged threads and replace as required.

c. Reassembly and Installation.

(1) Refer to figure 18-15 and reassemble the safety valve assembly as follows:

(a) Install retainer (6) in valve body (7).

(b) Install check ball (5), release pin (4) and spring (3) in valve body.

(c) Install adjusting nut (1) using the same number of turns to install as noted in removal.

(d) Install lock nut (2) and lock adjusting nut (1) in position.

(2) Refer to figure 18-1 and install safety valve assembly in reverse order of removal.

18-26. Pressure Valve Assembly

a. Removal and Disassembly.

(1) Refer to figure 18-1 and remove the pressure valve assembly as instructed.

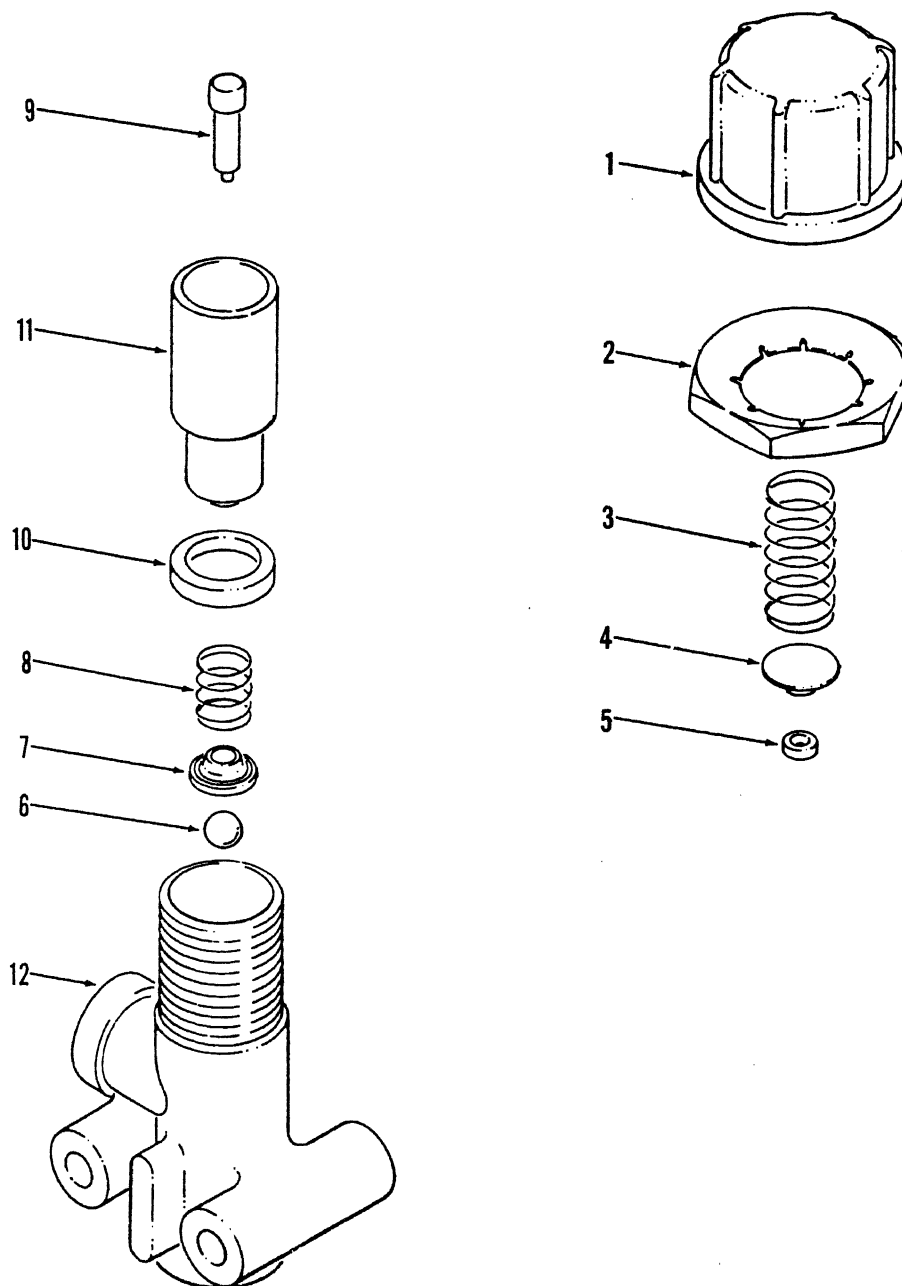
(2) Refer to figure 18-16 and disassemble the valve assembly as follows:

(a) Remove adjusting cover (1) from valve body (12).

NOTE

Take note of the number of turns required to remove adjusting cover.

(b) Remove nut (2) from valve body.



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- 1 Adjusting cover
- 2 Nut
- 3 Spring
- 4 Spring seat
- 5 Plunger
- 6 Check ball
- 7 Spring seat
- 8 Spring
- 9 Plunger
- 10 Packing
- 11 Housing
- 12 Valve body

Figure 18-16. Pressure valve assembly—exploded view.

(c) Remove spring (3), spring seat (4), plunger (5) and plunger (9) from housing (11).

(d) Remove housing (11) from valve body (12) and remove spring (8), spring seat (7) and check ball (6).

(e) Remove packing (10) from housing (11).

b. Cleaning, Inspection and Repair.

(1) Clean all metal parts of the pressure valve assembly with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly.

(2) Inspect all parts of the valve assembly for cracks, breaks, excessive wear or other damage. Repair or replace as necessary.

(3) Inspect all fittings and hardware for stripped or damaged threads and replace as necessary.

c. Reassembly and Installation.

(1) Refer to figure 18-16 and reassemble the pressure valve assembly as follows:

(a) Install check ball (6), spring seat (7) and spring (8) in valve body (12).

(b) Install new packing (10) on housing (11) and install housing in valve body (12).

(c) Install plunger (9), plunger (5), spring seat (4) and spring (3) into housing (11).

(d) Screw nut (2) on to valve body for enough to install adjusting nut.

(e) Install adjusting nut (1) to the valve body the number of turns noted in removal.

(f) Lock adjusting nut (1) in position with lock nut (2).

(2) Refer to figure 18-1 and install the pressure valve assembly in reverse order of removal.

18-27. Push Pull Control Valve

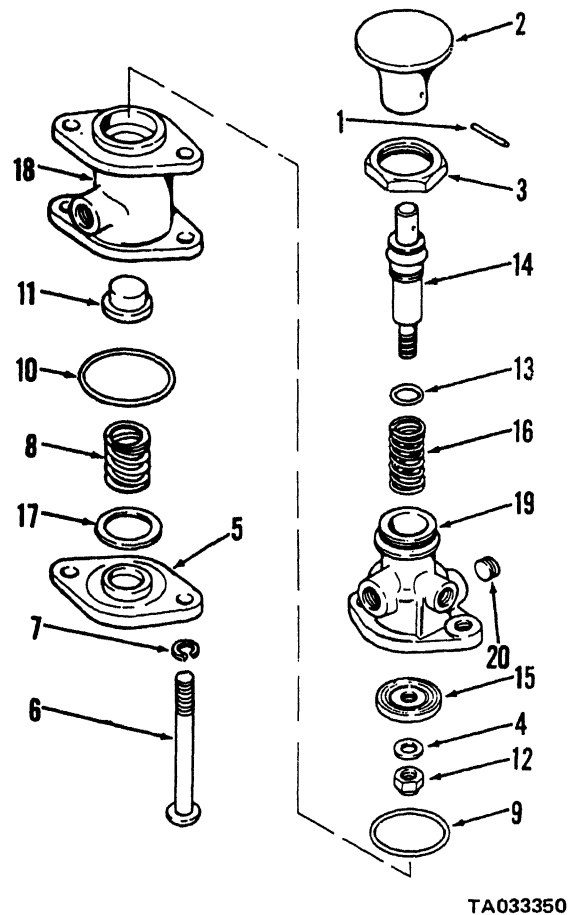
a. Removal and Disassembly.

(1) Refer to figure 18-1 and remove the push pull control valve as instructed.

(2) Refer to figure 18-17 and disassemble the control valve as follows:

(a) Remove spring pin (1) and remove push button (2) from plunger (14).

(b) Remove nut (3) from upper body (19).



1 Spring pin
2 Push button
3 Nut
4 Washer
5 Valve cover
6 Screw
7 Lockwasher
8 Spring
9 Packing
10 Packing

11 Piston
12 Nut
13 Packing
14 Plunger
15 Insert
16 Spring
17 Packing
18 Valve body
19 Upper body
20 Pipe plug

Figure 18-17. Push pull control valve—exploded view.

(c) Remove screw (6) and lockwasher (7) and separate the valve cover (5), valve body (18) and upper body (19).

(d) Remove spring (8) and piston (11) from the valve body.

(e) Remove and discard packing (9 and 10) from valve body (18).

(f) Remove and discard packing (17) from valve cover (5).

(g) Remove nut (12), washer (4) and insert (15) from plunger (14).

(h) Remove plunger (14) and spring (16) from upper body (19).

(i) Remove and discard packing (13) from plunger (14).

(j) Remove pipe plug (20) from the upper valve body.

b. Cleaning, Inspection and Repair.

(1) Clean all metal parts of the push pull control valve with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly.

(2) Inspect all parts of the control valve for breaks, cracks, excessive wear or other damage and repair as necessary.

(3) Inspect all fittings and hardware for stripped or damaged threads and replace as necessary.

c. Reassembly and Installation.

(1) Refer to figure 18-17 and reassemble the push pull control valve as follows:

(a) Install pipe plug (20) in the upper valve

body.

(b) Install new packing (13) on plunger (14) and install plunger and spring (16) in upper body (19).

(c) Install insert (15), washer (4) and nut (12) on plunger (14).

(d) Install new packing (17) on valve cover (5) and new packing (9 and 10) on valve body (18).

(e) Install piston (11) and spring (8) into valve body (18) and mate the valve cover, valve body and upper body together. Secure with lockwashers (7) and screws (6).

(f) Install nut (3) on upper body (19).

(g) Install push button (2) on plunger (14) and secure with spring pin (1).

(2) Refer to paragraph 18-1 and install the push pull control valve in reverse order of removal.

18-28. Relay Valve Assembly

a. Removal and Disassembly.

(1) Refer to TM 5-3810-295-12 and remove the relay valve assembly as instructed.

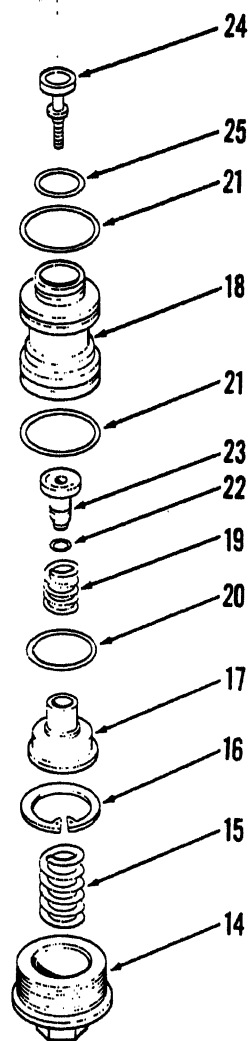
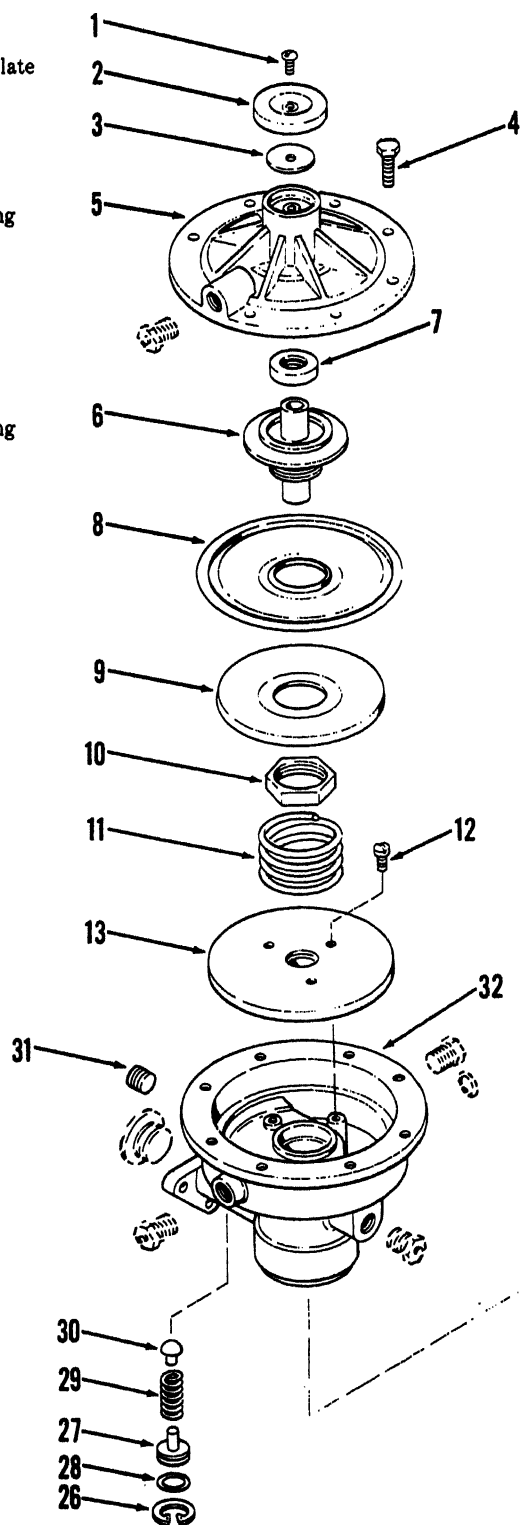
(2) Refer to figure 18-18 and disassemble the valve assembly as follows:

(a) Remove screw (1), exhaust cap (2) and diaphragm (3) from valve cover (5).

(b) Remove screws (4) and lift valve cover (5) from valve body (32).

(c) Remove plunger assembly (6) and spring (11). Remove nut (10), diaphragm plate (9) and diaphragm (8) from plunger. Remove seal (7) from plunger.

- 1 Screw
- 2 Exhaust cap
- 3 Diaphragm
- 4 Screw
- 5 Valve cover
- 6 Plunger
- 7 Seal
- 8 Diaphragm
- 9 Diaphragm plate
- 10 Nut
- 11 Spring
- 12 Screw
- 13 Baffle plate
- 14 End cap
- 15 Spring
- 16 Retaining ring
- 17 Valve guide
- 18 Piston
- 19 Spring
- 20 Packing
- 21 Packing
- 22 Packing
- 23 Valve
- 24 Valve
- 25 Packing
- 26 Retaining ring
- 27 Plug
- 28 Packing
- 29 Spring
- 30 Valve
- 31 Pipe plug
- 32 Valve body



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Figure 18-18. Relay valve assembly—exploded view.

(d) Remove screws (12) and lift baffle plate (13) from valve body (32).

(e) Remove end cap (14) and spring (15). Remove retaining ring (16) and remove piston assembly (18) from valve body (32).

(f) Remove valve guide (17) and spring (19) from piston (18). Remove and discard packing (20) from valve guide.

(g) Remove valves (23 and 24) from piston (18). Remove packing (21, 22 and 25) and discard.

(h) Remove retaining ring (26), plug (27), spring (29) and valve (30) from valve body (32).

(i) Remove packing (28) from plug (27). Discard packing.

(j) Remove pipe plug (31) from valve body (32).

b. Cleaning, Inspection and Repair.

(1) Clean all metal parts of the relay valve assembly with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly.

(2) Inspect all parts of the relay valve assembly for cracks, breaks, excessive wear or other damage. Repair or replace as necessary.

(3) Inspect all fittings and hardware for stripped or damaged threads. Replace as required.

c. Reassembly and Installation.

(1) Refer to figure 18-18 and reassemble the relay valve assembly as follows:

(a) Install pipe plug (31) into valve body (32).

(b) Install new packing (28) on plug (27) and install valve (30), spring (29) and plug (27) into valve body. Secure with retaining ring (26).

(c) Install new packing (21, 22 and 25) and install valves (23 and 24) into piston (18).

(d) Install new packing (20) on valve guide (17). Install spring (19) and valve guide (17) into piston (18) and secure with retaining ring (16).

(e) Install piston assembly in valve body (32) and install spring (15) and end cap (14).

(f) Place baffle plate (13) in proper position in valve body (32) and secure with screws (12).

(g) Assemble diaphragm (8), diaphragm plate (9) and new seal (7) to plunger (6). Secure diaphragm and diaphragm plate with nut (10).

(h) Install spring (11) and plunger assembly to the valve body and position valve cover (5) on valve body. Secure with screws (4).

(i) Install diaphragm (3) and exhaust cap (2) to the valve cover. Secure with screw (1).

(2) Refer to TM 5-3810-295-12 and install the relay valve assemblies.

CHAPTER 19

REPAIR OF CARRIER CAB, FRAME AND ACCESSORIES

Section I. REPAIR OF CARRIER CAB

19-1. Description

The carrier cab is a sheet metal and glass enclosed structure, designed to accommodate one man. The cab contains all controls and instruments required to operate the carrier and can be removed as a complete unit.

19-2. Removal

Refer to figure 19-1 and remove the carrier cab as follows:

a. Disconnect steering assembly as described in paragraph 17-9.

b. Tag and disconnect all hydraulic lines at connections that will allow removal of carrier cab assembly.

c. Tag and disconnect all electrical leads required to allow removal of cab assembly (para 13-46).

d. Tag and disconnect all air lines necessary, to allow removal of cab assembly (para 18-1).

e. Disconnect all controls necessary, to allow removal of cab assembly.

f. Remove attaching hardware (fig. 9-1).

g. Using a suitable lifting device, lift cab assembly off frame.

19-3. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly.

b. Inspect complete cab assembly for cracks, breaks, and other damage. Repair cracks and breaks by welding.

c. Replace an excessively damaged or defective cab assembly.

19-4. Installation

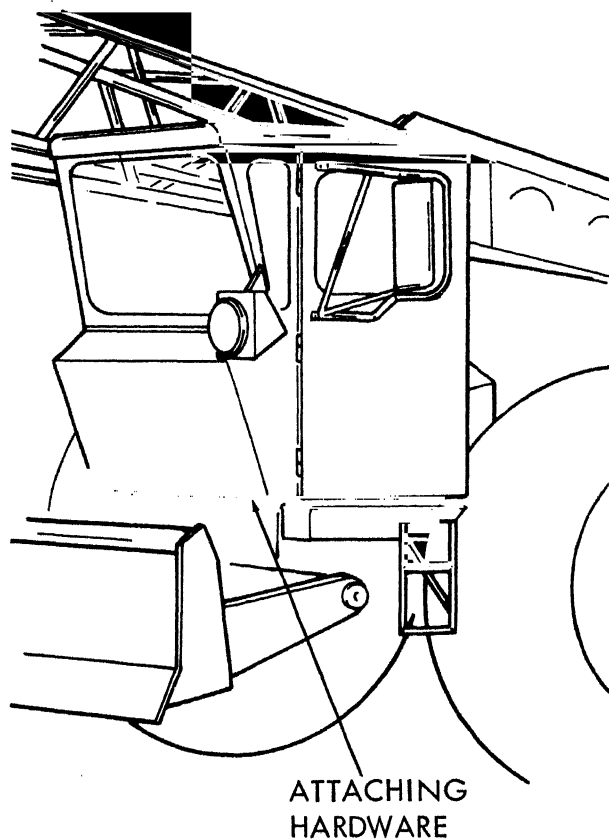
Refer to figure 19-1 and install cab assembly as described below:

a. Using a suitable lifting device, place cab assembly in its proper position on the frame.

b. Install attaching hardware (fig. 9-1).

c. Connect all air lines, electrical leads and hydraulic lines that were removed and tagged in removal procedure.

d. Connect steering assembly as described in paragraph 17-13.



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Figure 19-1. Carrier cab, removal and installation.

Section II. REPAIR OF CARRIER SEATS AND SEAT BELTS

19-5. Description

The operator's seat is contour designed for proper positions and comfortable seating. Built-in shock absorbers

aid in decreasing road jolts. The seat can be adjusted for proper back angle adjustment and front and back positioning.

19-6. Removal and Disassembly

a. Refer to TM 5-3810-295-12 and remove carrier operator's seat.

b. Refer to figure 19-2 and disassemble operator's seat as follows:

(1) Place wooden shim between base (68) and seat cushion assembly (5) at front of seat. Shim should be approximately 3 inches high to allow upper seat assembly to drop 1 inch.

(2) Remove pin (1) and rotate adjuster (27) counterclockwise to remove preload on torsion bars (39).

NOTE

Do not disengage adjuster assembly from seat at this time.

(3) Remove nuts (2), lock washers (3) and washers (4). Slide seat cushion assembly (5) forward and lift from assembly.

NOTE

Wire side panel assemblies (30) and (35) together across the front to retain their position before removing seat assembly.

(4) Remove clips (6) and lift cushion (7) from seat assembly (5). Remove bumpers (8).

(5) Remove cap screws (9) and lock washers (10). Lift back cushion assembly off. Remove clips (12) and remove cushion (13) from assembly (11).

(6) Remove snap rings (14) and top hinge shaft (15) through lever assembly (20).

(7) Remove snap rings (16), washers (17) and (18) and hinge shaft (19) from lever assembly (20).

(8) Remove lever assembly (20) from base (68) and remove rollers (21).

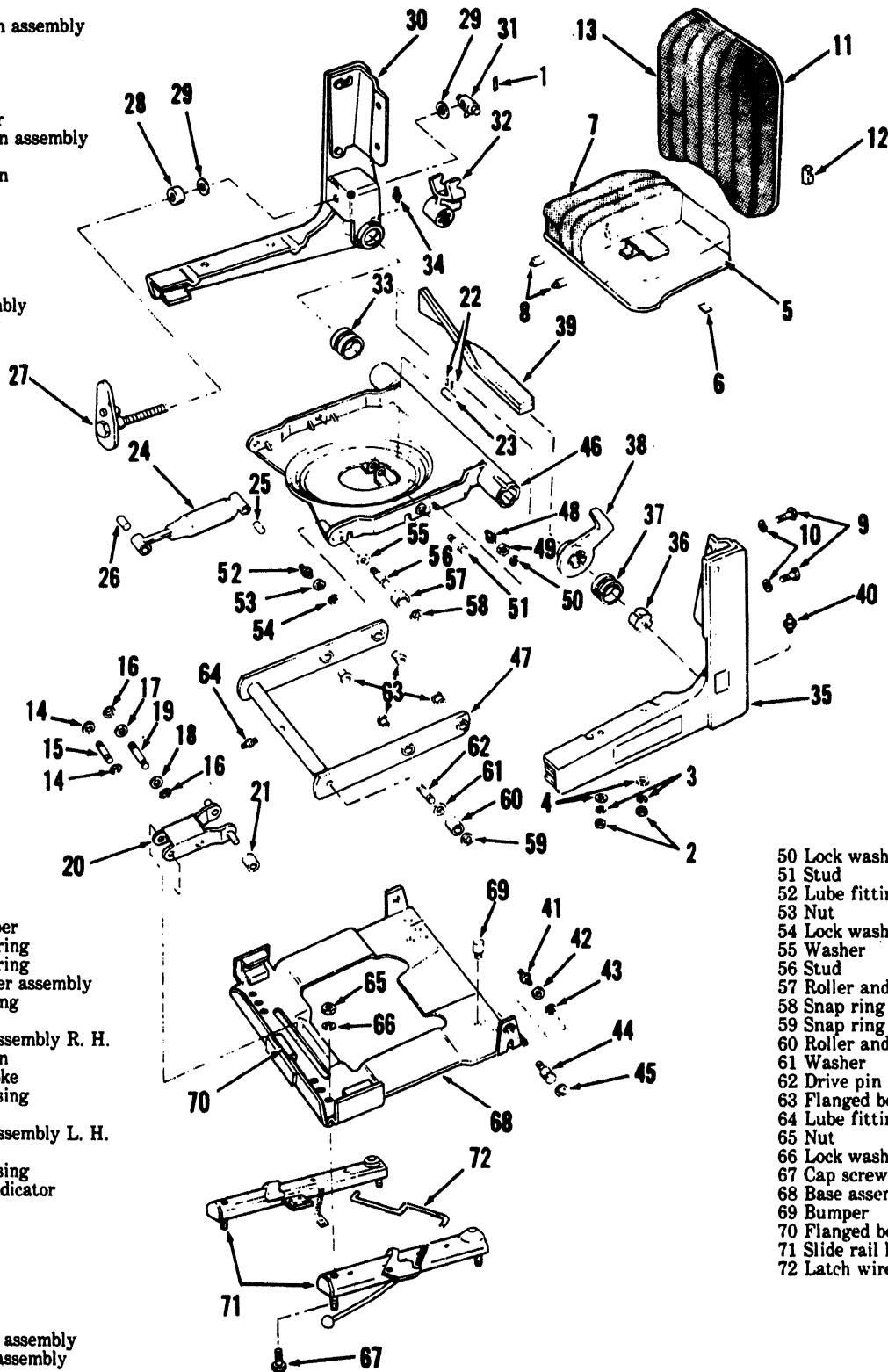
(9) With a small drift remove roll pin (22) and tap hinge shaft (23) out.

(10) Lift shock absorber (24) from center lever assembly (46) and remove bearings (25) and (26).

(11) Remove adjuster (27), bearing (28) and washers (29) from side panel (30).

(12) Tap side panel off center lever assembly (46) and remove adjusting pin (31), adjuster yoke (32) and bearing housing (33). Remove lube fitting (34) from panel (30).

- 1 Pin
- 2 Nut
- 3 Lock washer
- 4 Washer
- 5 Seat cushion assembly
- 6 Clip
- 7 Cushion
- 8 Bumper
- 9 Cap screw
- 10 Lock washer
- 11 Back cushion assembly
- 12 Clips
- 13 Back cushion
- 14 Snap rings
- 15 Hinge shaft
- 16 Snap rings
- 17 Washer
- 18 Washer
- 19 Hinge shaft
- 20 Lever assembly
- 21 Nylon roller
- 22 Roll pin



- 23 Hinge shaft
- 24 Shock absorber
- 25 Flanged bearing
- 26 Flanged bearing
- 27 Adjuster lever assembly
- 28 Thrust bearing
- 29 Washer
- 30 Side panel assembly R. H.
- 31 Adjusting pin
- 32 Adjusting yoke
- 33 Bearing housing
- 34 Lube fitting
- 35 Side panel assembly L. H.
- 36 Retainer
- 37 Bearing housing
- 38 Ride level indicator
- 39 Torsion bar
- 40 Lube fitting
- 41 Lube fitting
- 42 Nut
- 43 Lock washer
- 44 Stud
- 45 Snap ring
- 46 Center lever assembly
- 47 Outer lever assembly
- 48 Lube fitting
- 49 Nut

- 50 Lock washer
- 51 Stud
- 52 Lube fitting
- 53 Nut
- 54 Lock washer
- 55 Washer
- 56 Stud
- 57 Roller and bearing assembly
- 58 Snap ring
- 59 Snap ring
- 60 Roller and bearing assembly
- 61 Washer
- 62 Drive pin
- 63 Flanged bearing
- 64 Lube fitting
- 65 Nut
- 66 Lock washer
- 67 Cap screw
- 68 Base assembly
- 69 Bumper
- 70 Flanged bearing
- 71 Slide rail kit
- 72 Latch wire kit

Figure 19-2. Operator's seat assembly—exploded view.

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(13) Tap side panel assembly (35) off center lever assembly (46) and remove retainer (36), bearing housing (37) and ride level indicator (38).

(14) Remove torsion bars (39) from center lever assembly (46).

(15) Remove lube fitting (40) from side panel assembly (35).

(16) Remove lube fitting (41), nuts (42), lock washers (43) and studs (44) from base assembly (70). Remove snap rings (45) from studs (44).

(17) Slide center lever assembly (46) forward and lift outer assembly (47) and center lever assembly (46) off base assembly (70).

(18) Remove lube fittings (48), nuts (49), lock washers (50) and studs (51) from center lever assembly (46). Separate outer lever assembly (47) and center lever assembly (46).

(19) Remove lube fittings (52), nuts (53), lock washers (54), washers (55), studs (56) and roller and bearing assemblies (57). Remove snap rings (58) from studs (56).

(20) Remove snap rings (59), roller and bearing assemblies (57). Remove snap rings (58) from studs (56).

(21) Remove flanged bearing (63) and lube fitting (64) from outer lever assembly (47).

(22) Remove nuts (65), lock washers (66) and cap screws (67). Separate the base assembly (68) from slide rail kit (71).

(23) Remove bumpers (69) and flanged bearing (70) from base assembly (68).

(24) Remove the latch wire kit (72) from slide rail kit (71).

c. Refer to TM 5-3810-295-12 and remove carrier operators seat belts.

19-7. Cleaning, Inspection, and Repair

a. Clean all metal parts with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly with compressed air. Clean cushions with soap and water.

b. Inspect all parts for cracks, breaks or bends or other damage. Straighten bends and weld cracks. Replace defective parts as necessary.

c. Inspect cushions for torn or ripped covers and broken springs. Replace damaged cushions.

d. Inspect carrier operators seat belt for fraying, tears or other damage. Replace if any damage is noted.

19-8. Reassembly and Installation

a. Refer to figure 19-2 and reassemble the carrier operator's seat assembly as follows:

(1) Assemble latch wire kit (72) to the slide rail assembly (71).

(2) Press flanged bearings (70) into base assembly (68). Install bumpers (69).

(3) Assemble base assembly (68) to slide rail assembly (71) with cap screws (67), lock washers (66) and

nuts (65).

(4) Install lube fitting (64) and press flanged bearings (63) in outer lever assembly (47).

(5) Place drive pins (62) into outer lever assembly (47) and assemble washers (61), roller and bearing assemblies (60) and snap rings (59) on drive pin (62).

(6) Install studs (56), washers (55), lock washers (54), nuts (53) and lube fittings (52) on center lever assembly (46).

(7) Place roller and bearing assemblies (57) or studs (56) and secure with snap rings (58).

(8) Assemble outer lever assembly (47) to center lever assembly (46) with studs (51), lockwashers (50) nuts (49) and lube fittings (48).

(9) Slide center lever assembly (46) on base assembly.

(10) Connect back of outer lever assembly (47) to base assembly (68) with studs (44) through flanged bearings (63). Install snap rings (45), lockwashers (43) nuts (42) and lube fittings (41) to studs (44).

(11) Install lube fitting (40) to side panel assembly (35).

(12) Assemble ride lever indicator (38), bearing housing (37) and retainer (36) to torsion bars (39). Install torsion bars (39) in tube of center level assembly (46).

NOTE

Torsion bars must be engaged in retainer (36) inside tube at left hand side of seat assembly.

(13) Install lube fitting (34) in side panel (30). Assemble side panel (30) to center lever assembly (46) with bearing (33) and adjusting yoke (32) installed on torsion bars (39) during assembly.

(14) Line up side panels (30) and (35) with roller and bearing assemblies (57) properly positioned in side panels. Wire side panels (30) and (35) together maintaining a 20-inch dimension over side panels.

(15) Assemble adjusting pin (31) washers (29), thrust bearing (28) and adjusting lever assembly (27) to side panel (30). Do not preload torsion bars (39) by tightening adjusting lever assembly (27).

(16) Assemble flanged bearings (26) and (25) to shock absorber (24) and place shock absorber (24) in position on center lever assembly (46).

(17) Install hinge shaft (23) through flanged bearings (25) and install roll pins (22).

(18) Assemble rollers (21) to lever assembly (20). Install lever assembly (20) to base assembly (68) by inserting hinge shaft (15) through lever assembly (20) and flanged bearings (70). Secure with snap rings (14).

(19) Assemble shock absorbers (24) to lever assembly (20) by inserting hinge shaft (19) through lever assembly (20), washers (17) and (18), and flanged bearings (26). Secure with snap rings (16).

(20) Install bumpers (8) on seat cushion assembly (5). Assemble cushion (7) to seat cushion assembly with

clips (6).

(21) Assemble seat cushion assembly (5) to center lever assembly (46) by moving seat from the front of seat toward the rear being sure to engage rollers (24) properly in housing under cushion. Secure with washers (4), lock washers (3) and nuts (2).

(22) Assemble back cushion (13) to back cushion assembly (11) with clips (12). Install back cushion assembly (11) to side panels (30) and (35), secure with

lock washers (10) and cap screws (9).

(23) Preload torsion bars (39) by turning adjusting lever (27) clockwise. Install pin (1) in screw of adjusting lever assembly (27).

b. Refer to TM 5-3810-295-12 and install carrier operator's seat assembly.

c. Refer to TM 5-3810-295-12 and install carrier operator's seat belt assembly.

Section III. REPAIR OF CARRIER CAB HEATER ASSEMBLY

19-9. Description

The carrier cab heater is a liquid coolant type heater with a capacity of 20,000 BTU/HR. The blower motor is a 24 VDC motor controlled by a switch in the carrier cab.

19-10. Removal and Disassembly

a. Refer to TM 5-3810-295-12 and remove the carrier cab heater.

b. Refer to figure 19-3 and disassemble the carrier cab heater as follows:

(1) Remove cap screws (1) and lock washers (2). Remove heater jacket (3) and core (4).

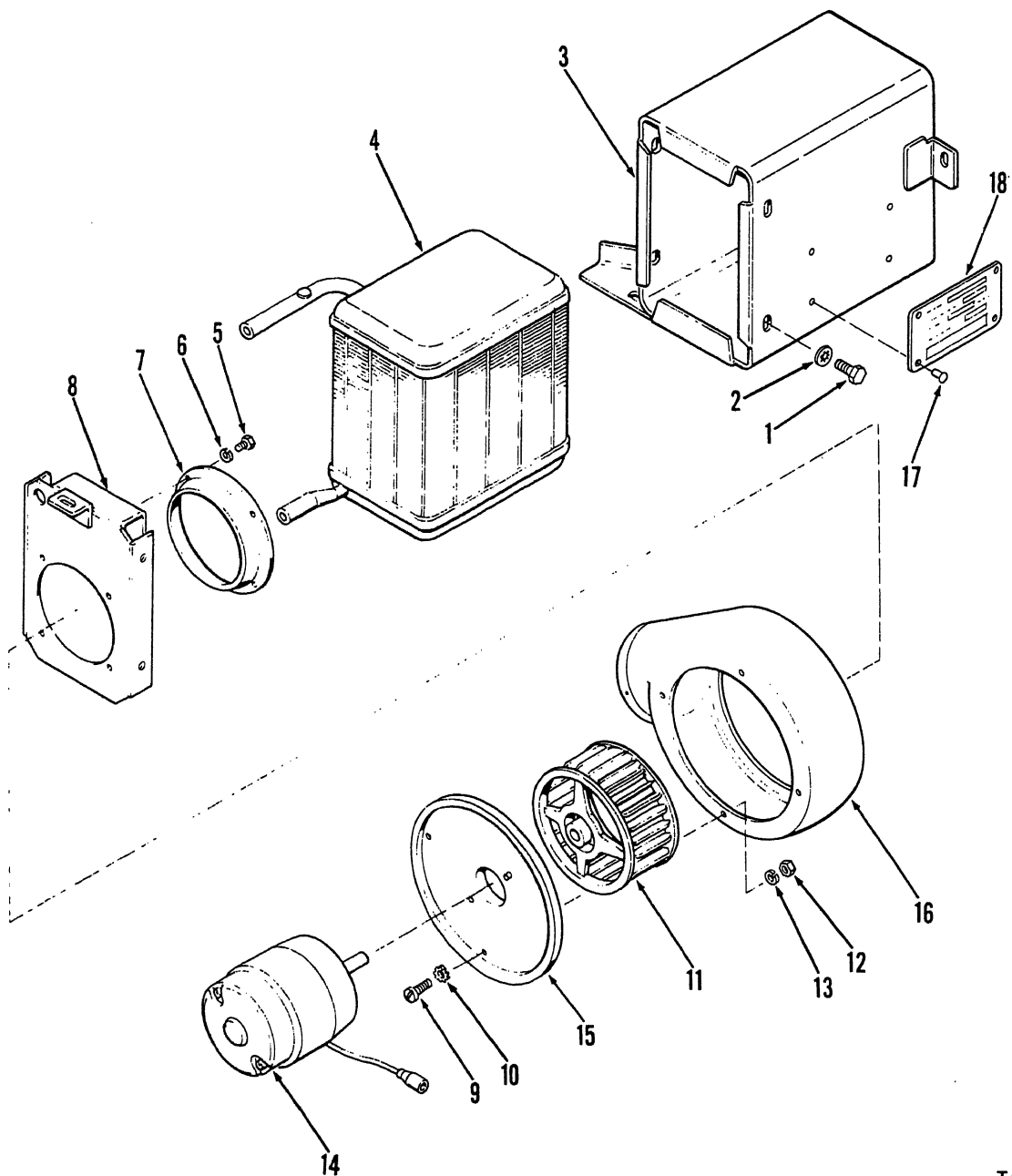
(2) Remove screws (5), and lock washers (6). Lift housing flange (7) and jacket retainer (8) from housing (16). Separate housing flange (7) and jacket retainer (8).

(3) Remove screws (9), lock washers (10) and (13), and nuts (12). Remove motor and impeller assembly from housing (16).

(4) Pull impeller assembly (11) from shaft of motor (14).

(5) Separate motor (14) and flange (15).

(6) Remove rivets (17) and data plate (18) from housing (16).



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- 1 Cap screw
- 2 Lock washer
- 3 Heater jacket
- 4 Core w/tank
- 5 Screw
- 6 Lock washer

- 7 Housing flange
- 8 Jacket retainer
- 9 Screw
- 10 Lock washer
- 11 Impeller assembly
- 12 Nut

- 13 Lock washer
- 14 Motor
- 15 Heater flange
- 16 Heater housing
- 17 Rivet
- 18 Data plate

Figure 19-3. Carrier cab heater assembly—exploded view.

19-11. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly with compressed air.

b. Inspect heater for leaks, cracks, or other damage.

Replace defective heater. Inspect impeller assembly for any distortion or other damage. Replace all defective parts as necessary.

19-12. Reassembly and Installation

a. Refer to figure 9-2 and reassemble the carrier c

heater as follows:

- (1) Install data plate (18) with new rivets (17).
- (2) Assemble flange (15) and impeller (11) to motor (14).
- (3) Install motor and impeller assembly to housing (16). Secure with nuts (12), lockwashers (13) and (10) and screws (9).
- (4) Assemble jacket retainer (8) and housing

flange (7) to housing (16). Secure with lockwashers (6) and screws (5).

(5) Place case and tank assembly (4) in heater jacket (3) and assemble to jacket retainer (8) with lockwasher (2) and cap screws (1).

b. Refer to TM 5-3810-295-12 and install carrier cab heater.

Section IV. REPAIR OF CARRIER WIRING HARNESS

19-13. Description

The wiring harness covered in this section include all wiring harnesses used in the carrier. Complete wiring harnesses should not be removed unless many electrical leads have been damaged.

19-14. Removal

Refer to figure 19-4 to locate termination points of

electrical leads and remove harness as follows:

- a. With an ohmmeter determine electrical lead continuity.
- b. Tag and disconnect all electrical leads.
- c. Tag and disconnect all electrical connectors.
- d. Lift harness from its mounting position.

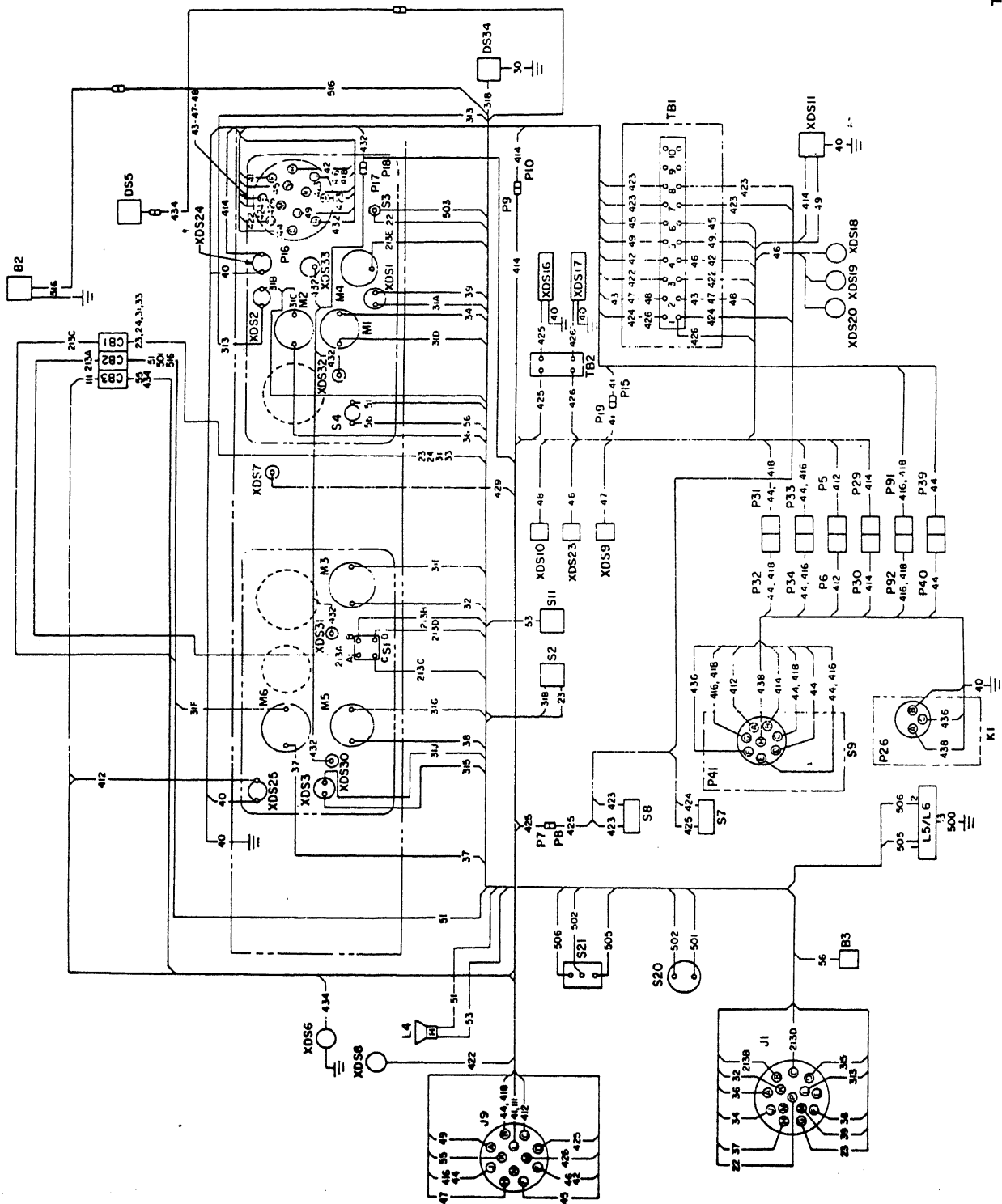
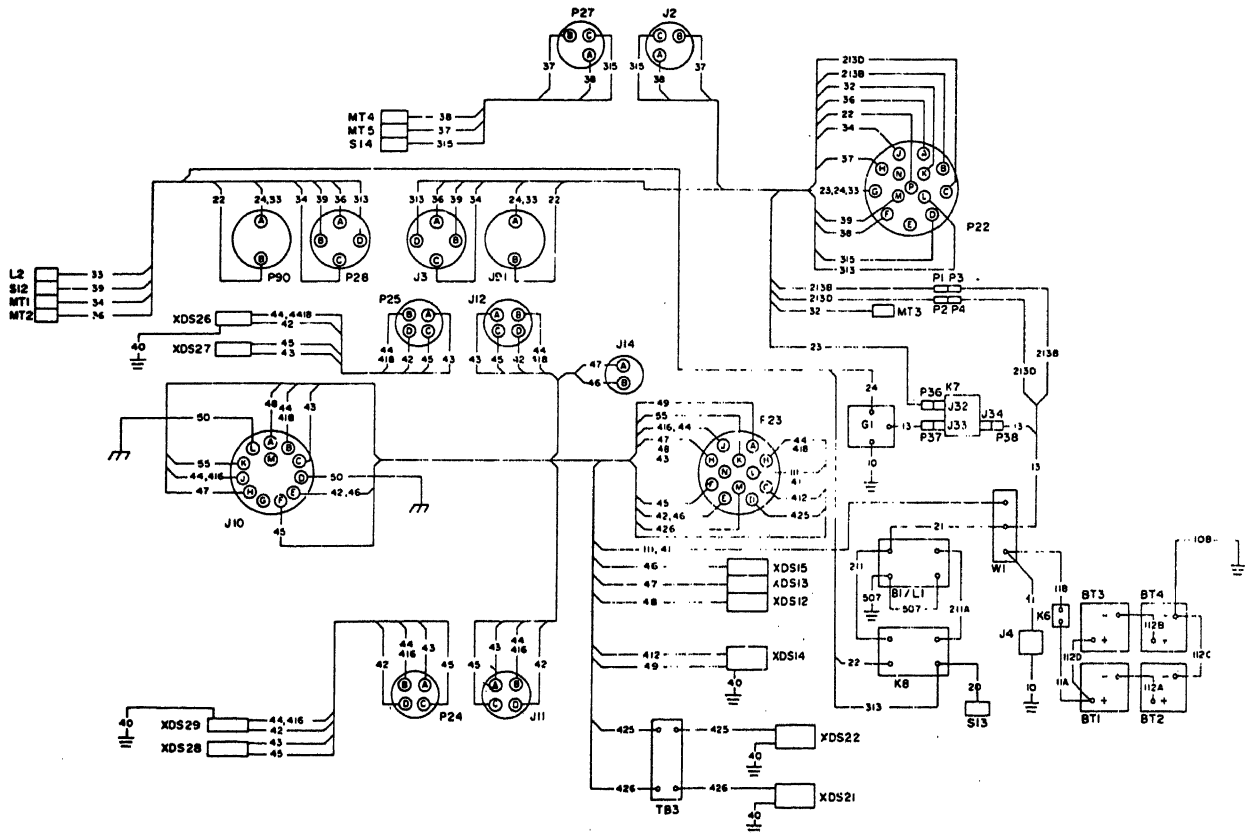


Figure 19-4. Carrier wiring harness (sheet 1 of 2).

Key to Fig. 19-4:

Reference	Description	Reference	Description
B1	Starter motor	L2	Rule solenoid
B2	Defroster fan	L4	Horn solenoid
B3	Heater fan	L5, L6	Valve solenoid
BT1, BT2, BT3, BT4	Battery storage	M1	Indicator temperature
CB1, CB2, CB3	Circuit breaker	M2, M5	Pressure indicator
DS1, 2, 3, 24, 25	Light indicator assembly	M3	Fuel indicator
DS5	Light dome	M4	Generator indicator
DS6	Light trouble	M6	Temperature indicator
DS7	Lamp assembly	MT1, MT5	Temperature transducer
DS8	Headlight blackout	MT2, MT4	Pressure transducer
DS9, DS13	Light marker	MT3	Fuel transmitter
DS10, DS12	Light marker	P16	Electrical connector
DS11, 14, 26, 29	Light turn signal	S1	Rotary switch
DS15, 18, 19, 20, 23	Light marker	S2	Pressure warning switch
DS16, 21	Headlamp	S3	Push button switch assembly
DS27, DS28	Stop light taillight	S4	Toggle switch
DS30, DS31, DS32, DS33	Lamp assembly	S6	Light switch
DS34	Buzzer	S7	Beam selecting switch
G1	Rectified AC generating system	S8	Stoplight switch
J4	Receptacle electrical slave	S9	Signal light control
J10	Connector receptacle	S11	Horn button
J14	Electrical connector	S12	Thermostatic switch
K1	Flasher	S13	Pressure warning switch
K6	Pull switch	S14	Hydraulic filter
K7	Relay	S20	Neutral start switch
K8	Magnetic switch	S21	Lock out switch
L1	Starter solenoid	W1	Bus bar



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Figure 19-4. Carrier wiring harness (sheet 2 of 2).

19-15. Cleaning, Inspection and Repair

a. Check all wiring for frayed insulation broken wires, corroded terminals, loose terminals and ground connections, and broken or missing cable clamps.

b. Repair damaged or broken wire by cutting a length of wire of the same size and color code and tapping it along the harness. Install two clips, one at each end, and remove the faulty wire. Secure the end of the new wire to the remaining end of the old wire. Insulate

the connections with electrical tape.

19-16. Installation

Refer to figure 19-4 to locate harness termination points and reinstall as follows:

a. Place harness carefully in its routed position in the carrier.

b. Note tags and connect all electrical leads and connectors.

c. Connect all clamps and straps.

Section V. REPAIR OF OUTRIGGERS AND PADS

19-17. Description

The carrier is equipped with four outriggers and float pads. The outriggers are hydraulically controlled and can be raised and lowered by individual levers mounted in the carrier cab.

19-18. Removal and Disassembly

a. Refer to TM 5-3810-295-12 and remove the outrigger float pads.

b. Refer to figure 19-5 and remove the outrigger assemblies as follows:

(1) Tag and disconnect all hydraulic lines to the

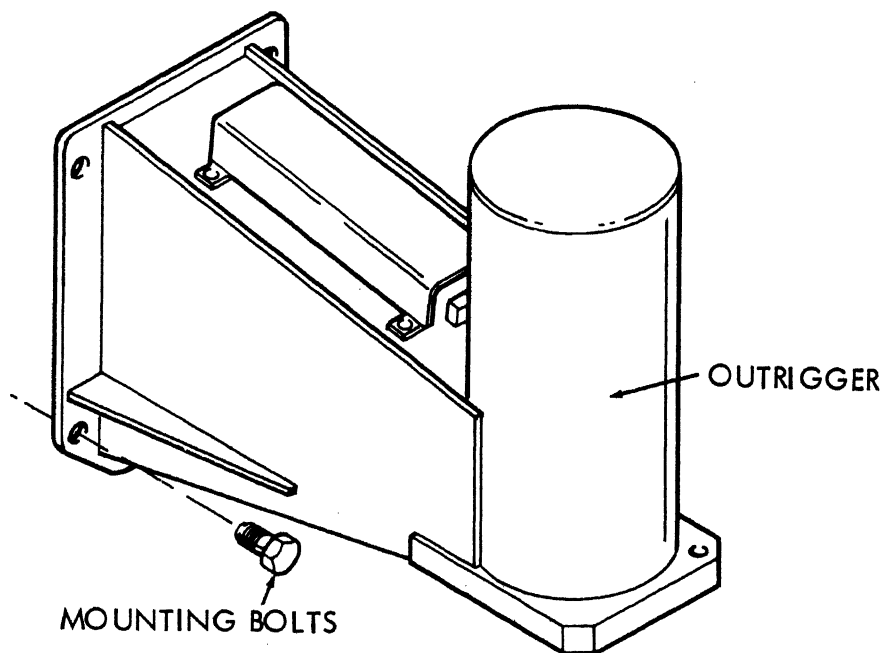
outrigger assembly.

(2) Remove four mounting bolts and with a suitable lifting device remove outrigger assembly from the frame.

c. Refer to figure 19-6 and disassemble the float pads as follows:

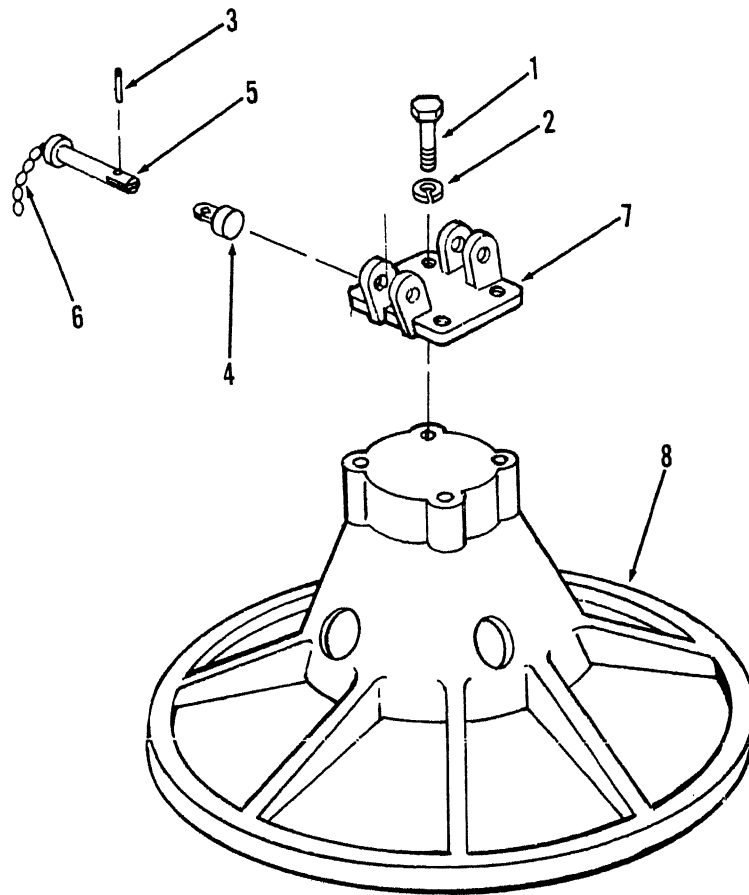
(1) Remove cap screws (1) and lock washers (2). Lift float plate (7) of outrigger float pad (8).

(2) Remove roll pin (3) and separate toggle pin (4) from pin (5). Remove chain (6) from pin (5).



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Figure 19-5. Outrigger assembly removal.



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- 1 Cap screw
- 2 Lockwasher
- 3 Roll pin
- 4 Toggle pin
- 5 Bar pin
- 6 Chain
- 7 Float plate
- 8 Float pad

Figure 19-6. Float pad assembly—exploded view.

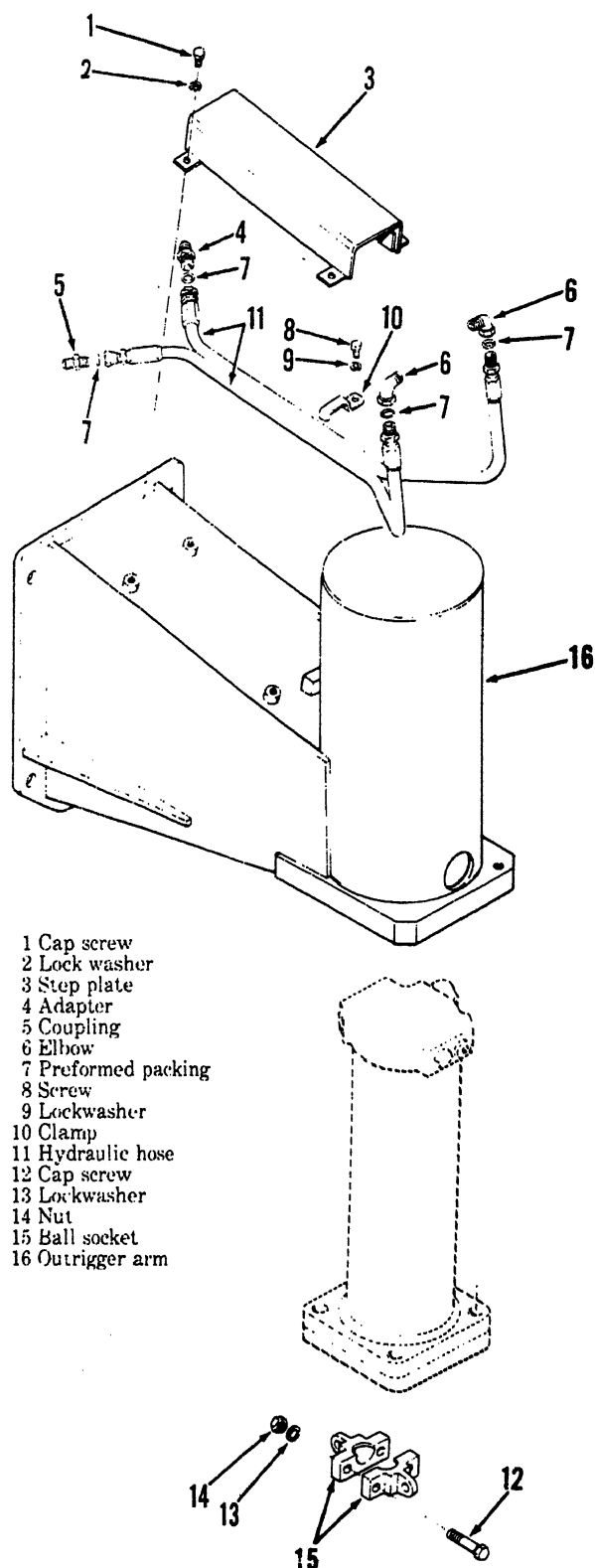
d. Refer to figure 19-7 and disassemble the front outrigger as follows:

(1) Remove cap screw (1) and lockwashers (2). Lift step plate (3) from outrigger arm (16).

(2) Remove adapter (4), coupling (5), elbow (6), and preformed packing (7) from hydraulic hoses (11).

(3) Remove cap screw (8), lockwasher (9) and clamp (10). Remove hydraulic lines (11).

(4) Remove cap screws (12), lockwashers (13) and nuts (14). Remove ball sockets (15) from hydraulic cylinder.



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e. Refer to figure 19-8 and disassemble the rear outrigger assemblies as follows:

(1) Remove adapter (1), coupling (2), elbow (3), and preformed packing (4) from hydraulic lines (8).

(2) Remove cap screw (5), lockwasher (6) and clamp (7). Remove hydraulic lines (8).

(3) Remove screws (9) and lockwashers (10). Remove light assembly.

(4) Remove screws (11) and lift lamp (12) and lamp ring (13) away from outrigger arm (23). Disconnect lead (14).

(5) Remove screws (15), lockwashers (16) and nuts (17). Remove safety reflectors (18).

(6) Remove cap screws (19), lockwashers (20), and nuts (21). Remove ball socket halves (22) from hydraulic cylinder.

Figure 19-7. Front outrigger assembly—exploded view.

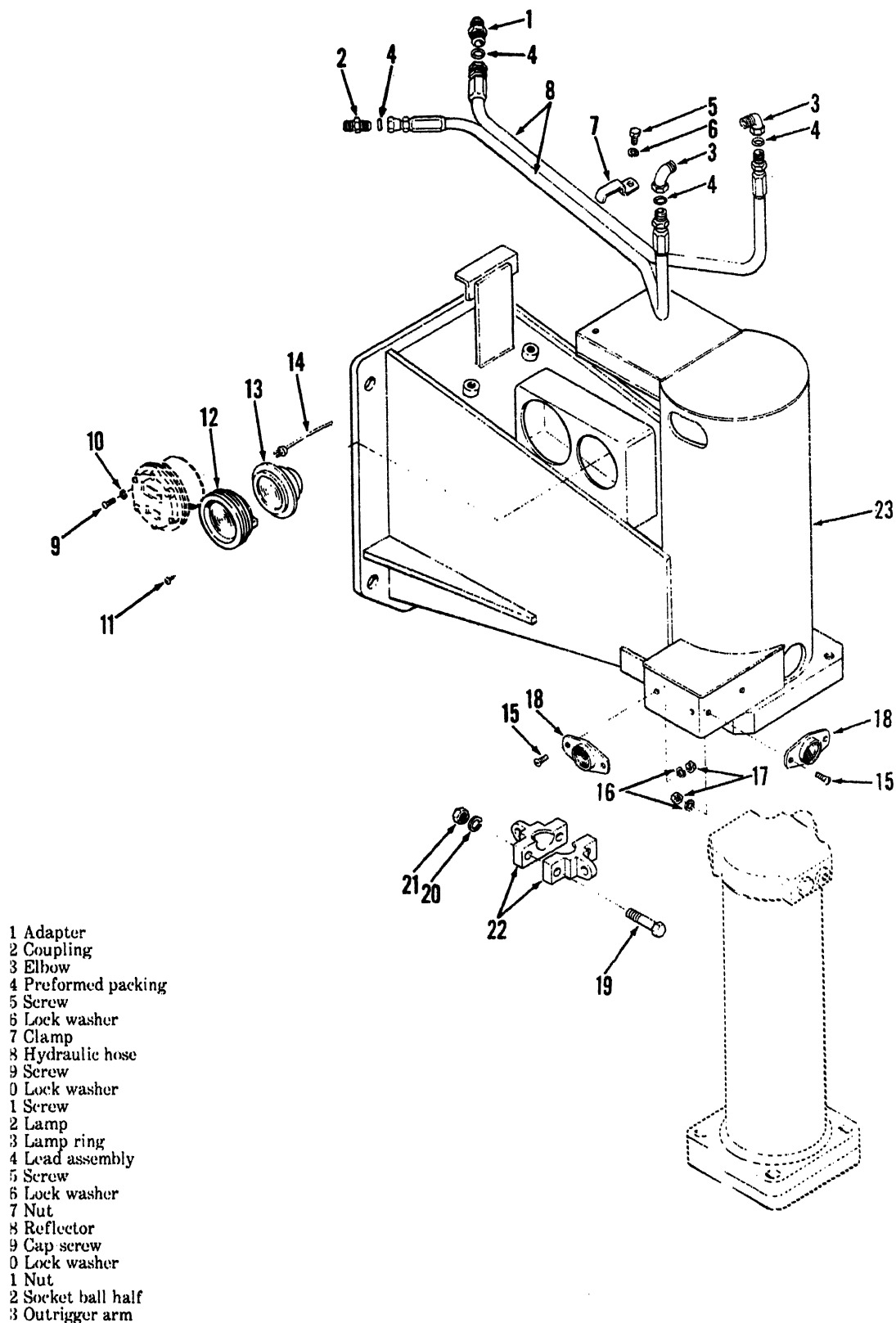


Figure 19-8. Rear outrigger assembly—exploded view.

19-19. Cleaning, Inspection and Repair

a. Clean all parts with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly with compressed air.

b. Inspect all parts for cracks, breaks, or other damage.

c. Repair or replace all defective parts. Repair parts by welding when necessary.

d. Replace all preformed packing when reassembling.

19-20. Reassembly and Installation

a. Refer to figure 19-6 and reassemble the float pad assembly as follows:

(1) Install chain (6) on bar pin (5). Assemble bar pin (5) to toggle pin (4) with roll pin (3).

(2) Assemble float plate (7) to float pad (8) with lockwashers (2) and cap screws (1).

b. Refer to figure 19-7 and reassemble the front outrigger assembly in the following manner.

(1) Place ball socket half (15) together on hydraulic cylinder ball and secure with nuts (14), lockwashers (13) and cap screws (12).

(2) Set hydraulic line (11) in proper position on outrigger arm (16) and install clamp (10). Secure with lockwasher (9) and screw (8).

(3) Install preformed packing (7), elbow (6), coupling (5) and adapter (4) on hydraulic lines (11).

(4) Assemble step plate (3) to outrigger arm (16).

Secure with lockwashers (2) and cap screws (1).

c. Refer to figure 19-8 and reassemble the rear outrigger assemblies as follows:

(1) Assemble ball socket halves (22) together on hydraulic cylinder. Secure with nuts (21), lockwashers (20) and cap screws (19).

(2) Install reflectors (18) on outrigger arm (23). Secure with nuts (17), lock washers (16) and cap screws (15).

(3) Connect lead assembly (14) to the lamp assembly and install lamp ring (13) and lamp (12) to outrigger arm (23) with screws (11).

(4) Install stop light assembly in outrigger arm (23) with lockwashers (10) and cap screws (9).

(5) Position hydraulic lines (8) on outrigger arm (23) and install clamp (7). Secure with lockwasher (6) and cap screw (5).

(6) Assemble preformed packing (4), elbow (3), coupling (2) and adapter (1) on hydraulic lines (8).

d. Refer to figure 19-5 and install the outrigger assemblies in the following manner.

(1) With a suitable lifting device position outrigger assembly to carrier frame and install four mounting bolts.

(2) Reconnect all hydraulic lines tagged in the removal procedure.

e. Refer to TM 5-3810-295-12 and install the outrigger float pads.

Section VI. REPAIR OF OUTRIGGER HYDRAULIC CYLINDERS

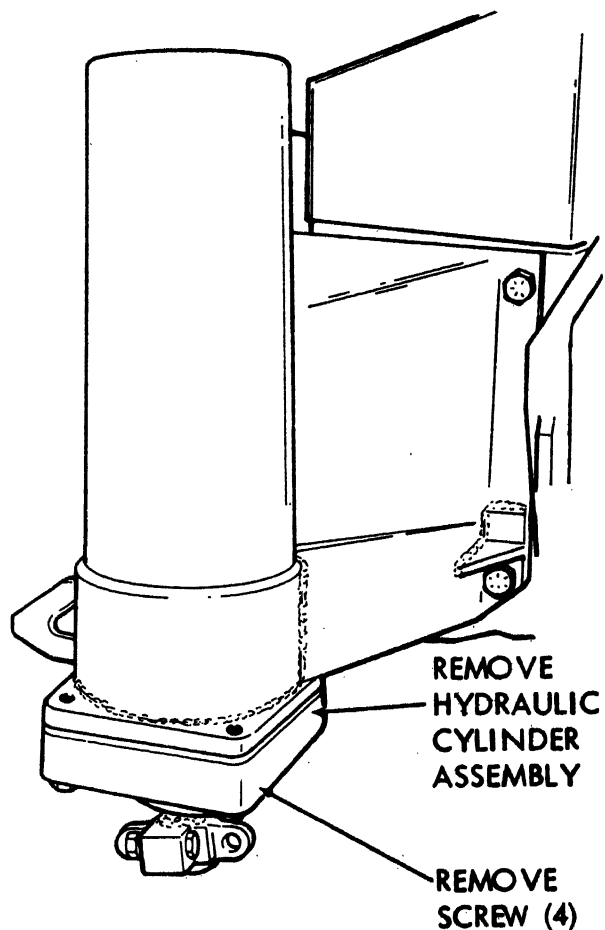
19-21. Removal and Disassembly

a. Refer to figure 19-9 and remove four mounting

screws and lockwashers and remove hydraulic cylinder from the outrigger assembly.

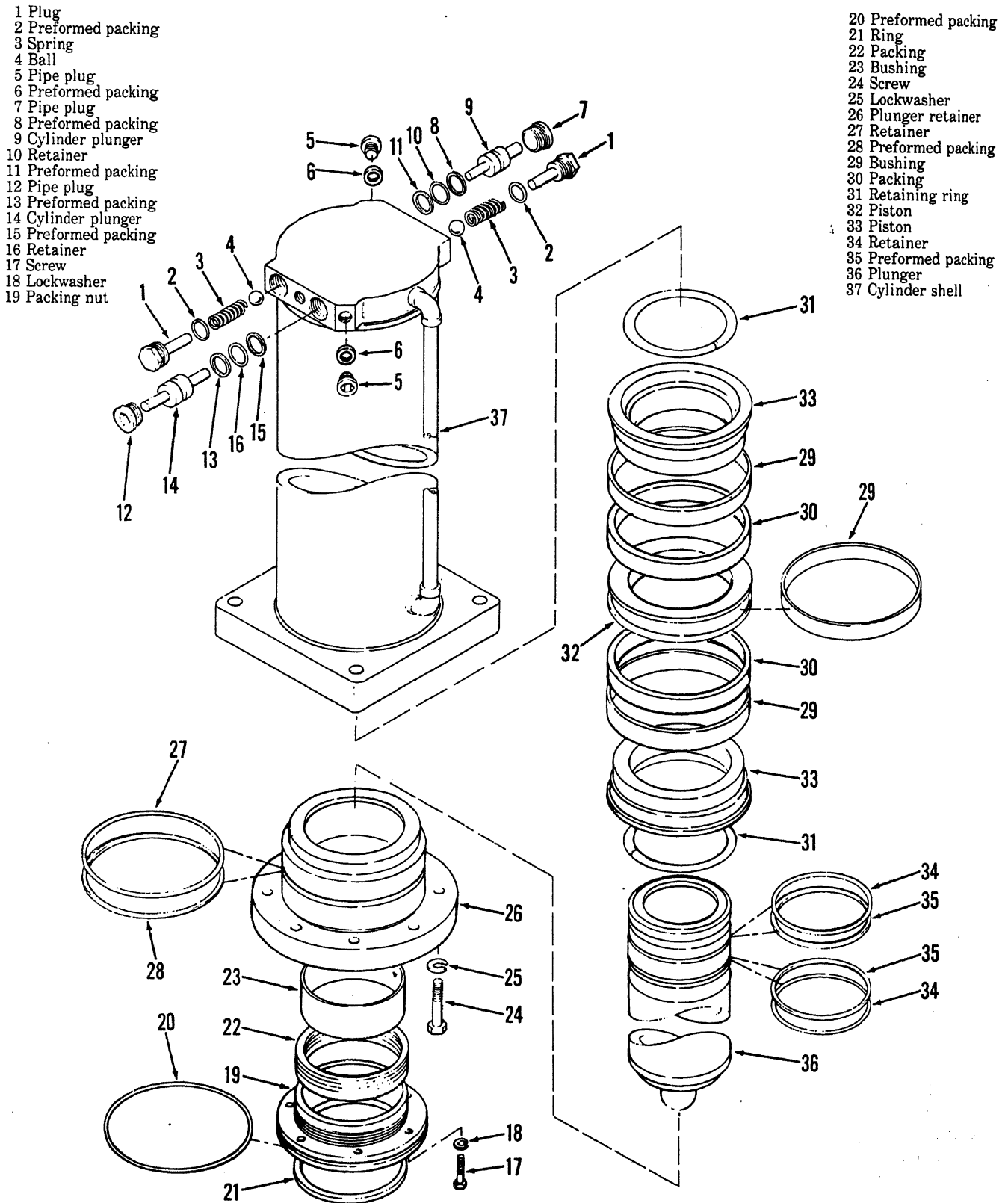
b. Refer to figure 19-10 and disassemble the hydraulic cylinder as described in the following:

(1) Remove plug (1), packing (2), spring (3), and check ball (4).



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Figure 19-9. Outrigger hydraulic cylinder, removal and installation.



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Figure 19-10. Outrigger hydraulic cylinder—exploded view.

(2) Remove pipe plug (5) and packing (6). Remove pipe plug (7), packing (8), plunger (9), retainer (10) and packing (11) from cylinder shell (37).

(3) Remove pipe plug (12), packing (13), plunger (14), packing (15), and retainer (16) from the cylinder shell.

(4) Remove screws (17) and lockwashers (18) and remove packing nut (19).

(5) Remove packing (20), wiper ring (21), packing (22), and bushing (23).

(6) Remove screws (24) and lockwashers (25) and remove retainer (26) from cylinder shell.

(7) Remove retainer (27) and packing (28) from plunger retainer (26).

(8) Remove plunger assembly from cylinder shell and remove bushing (29), packing (30), rings (31) and pistons (32 and 33).

(9) Remove retainer (34) and packing (35) from cylinder plunger (36).

19-22. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly.

b. Inspect rod, pistons and cylinder for cracks, scoring and excessive wear. Repair or replace all defective parts.

c. Replace all preformed packing and seals.

19-23. Reassembly and Installation

a. Refer to figure 19-10 and reassemble the outrigger hydraulic cylinder as follows:

(1) Install retainer (34) and new packing (35) on cylinder plunger (36).

(2) Install piston (33), piston (32), rings (31), pack-

ing (30) and bushing (29) on the cylinder plunger, place plunger (36) into cylinder shell (37).

(3) Assemble retainer (27) and new packing (28) to plunger retainer (26).

(4) Install retainer (26) on cylinder shell (37) and secure with lockwasher (25) and screws (24). Tighten screws (24) evenly to 50—60 ft-lb (67.8—81.3 N·m) torque.

(5) Install bushing (23) and packing (22) in retainer (26).

(6) Install wiper ring (21) and new packing (20) on packing nut (19) and install packing nut. Tighten packing nut (19) the required amount to align capscrew holes in the nut with the tapped holes in retainer (26). When packing nut is tight against packing (22) advancing capscrew one position (45°) will increase packing compression 0.011 inch.

(7) Install lockwasher (18) and screw (17) and tighten securely.

(8) Assemble retainer (16), packing (15), plunger (14), packing (13), and pipe plug (12) to the cylinder shell.

(9) Assemble packing (11), retainer (10), plunger (9), packing (8) and pipe plug (7) to cylinder shell (37).

(10) Assemble packing (6) and pipe plug (5) to the cylinder shell.

(11) Install bearing ball (4), spring (3), packing (2), and plug (1).

b. Refer to figure 19-9 and install the outrigger hydraulic cylinder as follows:

(1) Set hydraulic cylinder into cover assembly.

(2) Install four mounting screws and lockwasher. Tighten securely.

Section VII. REPAIR OF UTILITY BLADE ASSEMBLY

19-24. General

The earth moving equipment consists of a utility blade mounted on push beams attached to the carrier frame. The blade is hydraulically raised and lowered from the operator's cab.

19-25. Removal and Disassembly

a. Refer to figure 19-11 and remove the utility blade assembly as follows:

(1) With a suitable lifting device attached to the utility blade assembly remove mounting screws (38) and nuts (39).

(2) Remove cotter pins (21) and mounting pin (22) and lift utility blade assembly off the carrier.

b. Refer to figure 19-11 and disassemble the utility blade assembly as described below.

(1) Remove bolts (1), lockwashers (2) and nuts (3) and remove cutting edge (4) and bit edges (5 and 6).

(2) Remove screws (7), nuts (8) and pins (9 and 10) and remove blade bowl (11).

(3) Remove cotter pins (12), pins (13 and 16), clevis (14), nut (15), lever (17), pin (18), shaft (19) and cylinder hook (20).

(4) Remove lifting eye (23) and disassemble by removing retaining ring (24), bushing (25) and lube fitting (43).

- 1 Bolt
- 2 Lockwasher
- 3 Nut
- 4 Cutting edge
- 5 Bit edge
- 6 Bit edge
- 7 Screw
- 8 Nut
- 9 Pin
- 10 Pin
- 11 Blade bowl
- 12 Cotter pin
- 13 Pin
- 14 Clevis
- 15 Nut
- 16 Pin
- 17 Lever
- 18 Pin
- 19 Shaft
- 20 Hook
- 21 Cotter pin
- 22 Pin
- 23 Lifting eye
- 24 Retaining ring
- 25 Bushing
- 26 Screw
- 27 Lockwasher
- 28 Bearing block
- 29 Bushing
- 30 Screw
- 31 Nut
- 32 Bearing cap
- 33 Bushing
- 34 Upper arm
- 35 Screw
- 36 Nut
- 37 Bearing cap
- 38 Screw
- 39 Nut
- 40 Mounting arm
- 41 Mounting arm
- 42 Bushing
- 43 Lubrication fitting
- 44 Push beam
- 45 Locking arm

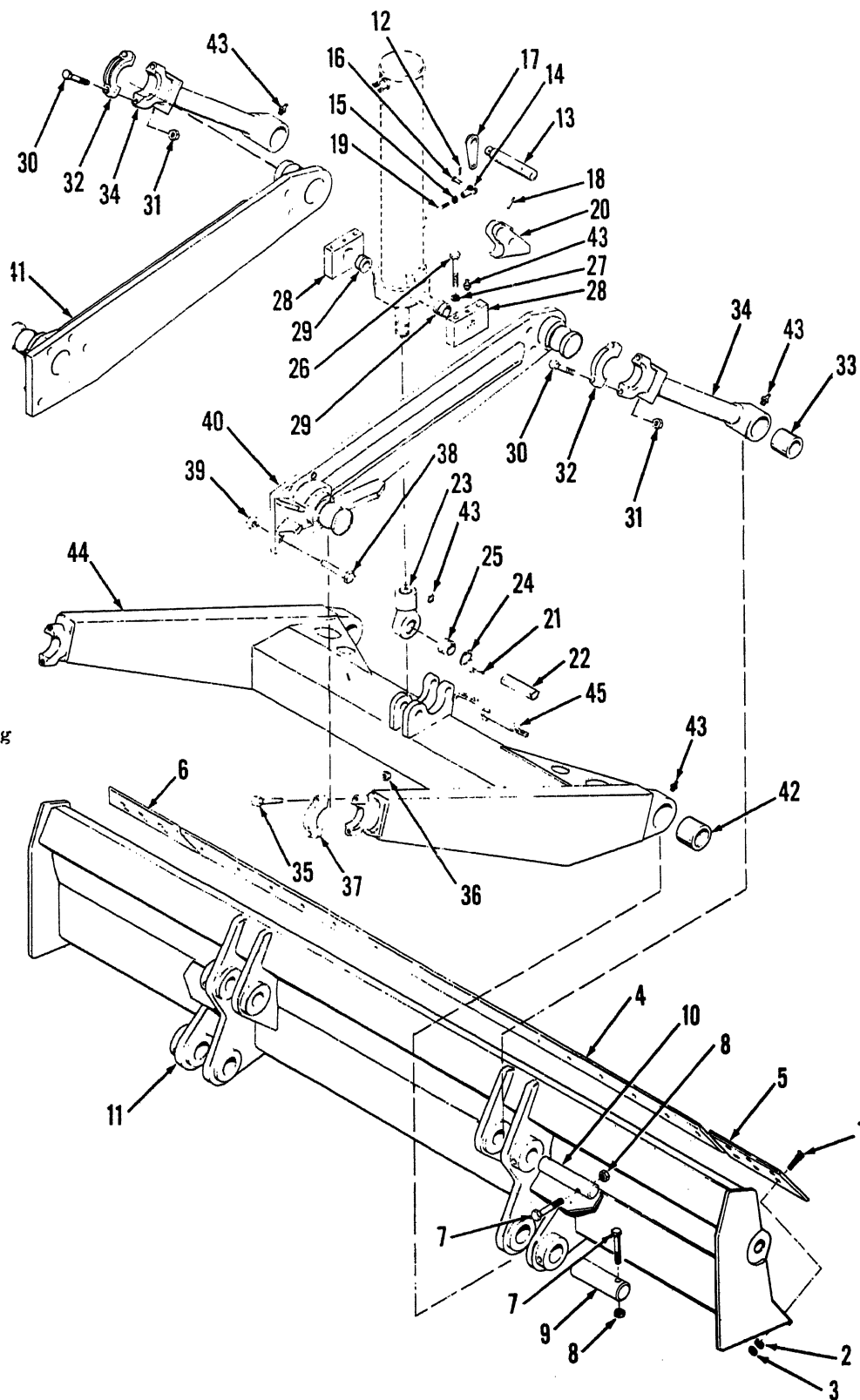


Figure 19-11. Utility blade assembly—exploded view.

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(5) Remove screws (26) and lockwashers (27) and lift bearing blocks (28) off. Remove bushings (29) from bearing blocks.

(6) Remove screws (30) and nuts (31) and remove bearing caps (32). Remove upper arms (34). If necessary remove bushings (33) from upper arm assemblies.

(7) Remove screws (35) and nuts (36) and remove bearing caps (37) and separate mounting arms (40 and 41) from push beam (44).

(8) If necessary remove bushings (42) from push beam. Remove lube fittings (43) and locking arm (45).

19-26. Cleaning, Inspection and Repair

a. Clean all metal parts with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly.

b. Inspect all parts for cracks and breaks by welding. Replace all defective parts as necessary.

c. Repair any minor cracks and breaks by welding. Replace all defective parts as necessary.

19-27. Reassembly and Installation

a. Refer to figure 19-11 and reassemble the utility blade assembly as follows:

(1) Install bushings (42) in push beam (44). Install lube fittings (43) in all locations required.

(2) Install locking arm (45) on push beam (44) and assemble mounting arms (40 and 41) to push beam. Secure with bearing caps (37), nuts (36) and screws

(35). Tighten securely.

(3) Install bushings (33) in upper arm assemblies (34). Assemble upper arm assemblies to mounting arms and secure with bearing caps (32), nuts (31) and screws (30). Tighten securely.

(4) Install bushings (29) in bearing blocks (28) and assemble bearing blocks (28) to carrier with lockwashers (27) and screws (26).

(5) Assemble fitting (43), bushing (25) and retaining ring (24) to lifting eye (23). Install lifting eye to hydraulic cylinder.

(6) Install cylinder hook (20), shaft (19), pin (18), lever (17), nut (15), clevis (14), pins (13 and 16) and cotter pin (12).

(7) With a suitable lifting device lift blade bowl (11) in position on push beam (44) and mounting arms (40 and 41) and install pins (9 and 10). Secure pins (9 and 10) with nuts (8) and screws (7).

(8) Install bit edges (5 and 6) and cutting edge (4) secure with nuts (3), lockwashers (2) and bolts (1).

b. Refer to figure 19-11 and reinstall the utility blade assembly as follows:

(1) With a suitable lifting device, lift blade assembly in position and install pins (9 and 10). Secure pins with screws (7) and nuts (8).

(2) Position lifting eye (23) to mounting arm assembly and install pin (22) and cotter pin (21).

Section VIII. REPAIR OF BLADE HYDRAULIC CYLINDER ASSEMBLY

19-28. Removal and Disassembly

a. Remove the blade hydraulic cylinder assembly as described below:

(1) Remove all hydraulic lines and plug or tape to eliminate entry of foreign material in lines.

(2) Refer to paragraph 19-25b. subparagraphs (3) through (5) and remove hydraulic cylinder.

b. Refer to figure 19-12 and disassemble the hydraulic cylinder as follows:

(1) Remove setscrew (1) and end cap (2) from cylinder shell (18).

(2) Remove wiper ring (3) from end cap (2).

(3) Remove nut (4), piston half (5), nylon rider (6), packing assembly (7), preformed packing (8), and piston half (9) from piston rod (10).

(4) Remove the remaining packing assembly (7), nylon rider (6), preformed packing (8) and piston half (5) from the piston rod.

(5) Remove packing assembly (11), bushing (12), rings (13), packing (14), retainer (15), packing (16), and ring (17) from cylinder shell (18).

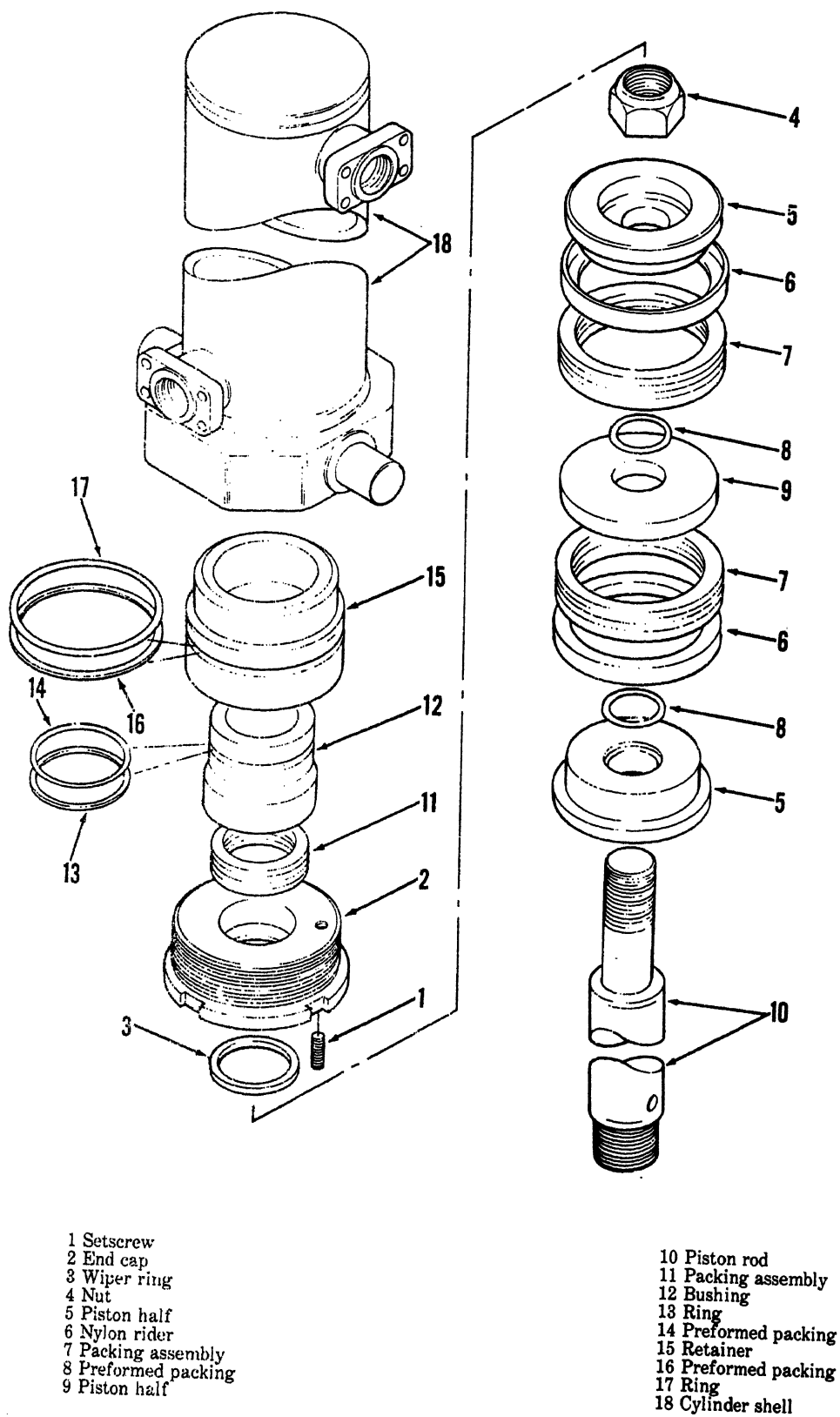


Figure 19-12. Hydraulic blade cylinder—exploded view.

19-29. Cleaning, Inspection and Repair

a. Clean all metal parts in cleaning solvent, (Fed. Spec. P-D-680, or equivalent) and dry thoroughly.

b. Inspect rod, pistons and cylinder shell for cracks, scoring or excessive wear. Repair or replace defective parts.

c. Replace all packings and seals.

19-30. Reassembly and Installation

a. Refer to figure 19-12 and reassemble the blade hydraulic cylinder as follows:

(1) Install ring (17), packing (16), retainer (15), packing (14), ring (13), bushing (12), and packing assembly (11) into cylinder shell (18).

(2) Install piston half (5), packing (8), nylon rider (6), packing assembly (7), and piston half (9) on piston rod (10).

(3) Install the remaining packing (8), packing assembly (7), nylon rider (6) and piston half (5) on the piston rod.

(4) Install nut (4) on piston rod (10) and torque to 600—700 ft-lb (813.5—949.1 N • m).

(5) Place wiper ring (3) in end cap (2) and install end cap (2) in cylinder (18). Torque the end cap to 10—12 ft-lb (13.6—16.3 N • m).

(6) Install setscrew (1) in end cap (2).

b. Install the blade hydraulic cylinder as described in the following:

(1) Refer to paragraph 19-27a (4) through (6) and install cylinder to carrier.

(2) Reinstall all hydraulic lines to the hydraulic cylinder.

19-30.1. Control Valve, Outrigger

a. Refer to figure 19-12.1 and remove the control valve as follows:

(1) Remove and cap all hydraulic lines to the control valve.

(2) Remove mounting hardware and lift control valve from vehicle.

b. Refer to figure 19-12.1 and disassemble the control valve as follows:

(1) Remove plug and body (1) from valve body (8).

(2) Remove check valve and ring (2) from valve body.

(3) Remove spool cap (3) and spool (4) from control valve.

(4) Remove relief valve and ring (5) from valve body (8).

c. Cleaning, Inspection and Repair.

(1) Clean all metallic parts with cleaning solvent (Fed Spec P-D-680, or equivalent) and dry thoroughly.

(2) Inspect for cracks, breaks, stripped threads, corrosion or other defects.

(3) Replace all gaskets, packing and defective parts.

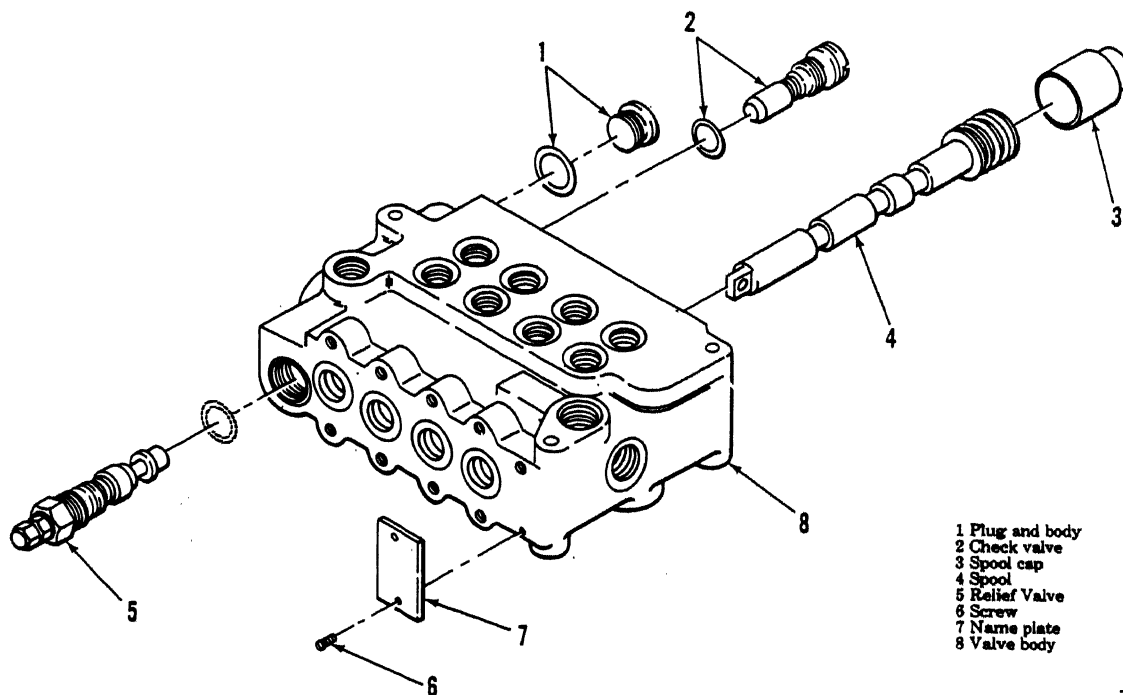
d. Refer to figure 19-12.1 and reassemble control valve as follows:

(1) Install relief valve and ring (5) into valve body (8).

(2) Install spool cap (3) and spool (4) into valve body (8).

(3) Install check valve and ring (2) into valve body.

(4) Install plug and body (1) into valve body.



- 1 Plug and body
- 2 Check valve
- 3 Spool cap
- 4 Spool
- 5 Relief Valve
- 6 Screw
- 7 Name plate
- 8 Valve body

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Figure 19-12.1. Control Valve, Outrigger

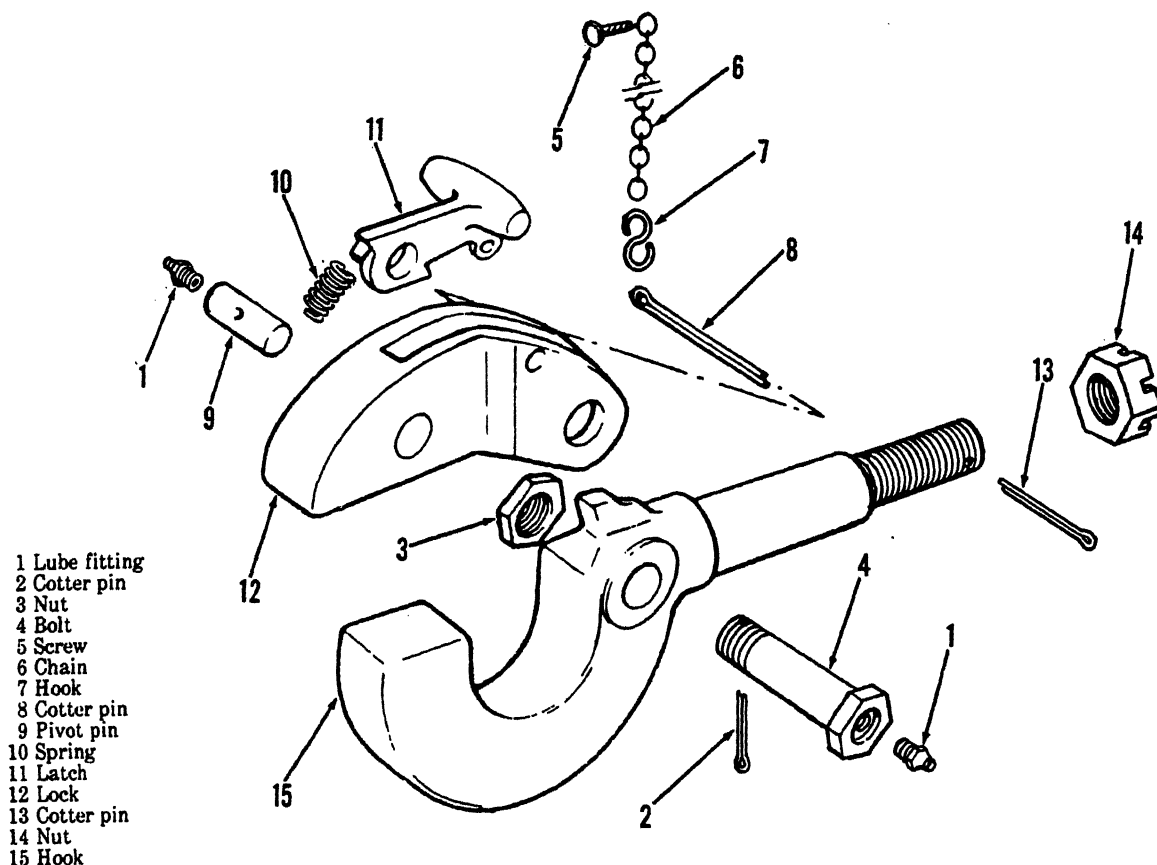
Section IX. REPAIR OF PINTLE HOOK ASSEMBLY

19-31. General

The pintle hook is mounted on the rear of the carrier frame to be used for towing purposes.

19-32. Removal and Disassembly

a. Refer to figure 19-13 and remove cotter pin (13) and nut (14) and remove pintle hook assembly (15) from the carrier frame.



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Figure 19-13. Pintle hook assembly—exploded view.

b. Refer to figure 19-13 and disassemble the pintle hook assembly as follows:

- (1) Remove lube fittings (1) from pivot pin (9) and bolt (4).
- (2) Remove cotter pin (2), nut (3), and bolt (4) and lift lock (12) off assembly.
- (3) Remove screw (5) and chain (6). Remove hook (7) from chain (6).
- (4) Remove cotter pin (8) and pivot pin (9) and lift latch (11) from lock (12). Remove spring (10) from latch (11).

19-33. Cleaning, Inspection and Repair

- a. Clean all metal parts with cleaning solvent (Fed. Spec. P-D-680 or equivalent) and dry thoroughly.
- b. Inspect all parts for cracks, breaks or other

damage.

c. Repair or replace all defective parts.

19-34. Reassembly and Installation

a. Refer to figure 19-13 and reassemble the pintle hook assembly as follows:

- (1) Assemble lock (12) by placing spring (10) in latch (11) and securing with pivot pin (9). Install cotter pin (8) in lock (12).
- (2) Assemble hook (7) to chain (6) and install chain to carrier with screw (5).
- (3) Place lock assembly (12) on hook (15) and install bolt (4), nut (3) and cotter pin (2).
- (4) Install lube fittings (1) in pivot pin (9) and bolt (4).

Section X. REPAIR OF ROTATING RING GEAR

19-35. General

The crane assembly rotating gear and rollers operate on a dual flanged center, hub-type ring gear. This ring gear is bolted to the carrier frame to serve as the swing or tracking gear for the crane assembly.

19-36. Removal

- Remove the crane assembly (para 2-18).
- Remove mounting capscrews.
- Using a suitable lifting device, lift ring gear from the carrier frame and place on blocks.

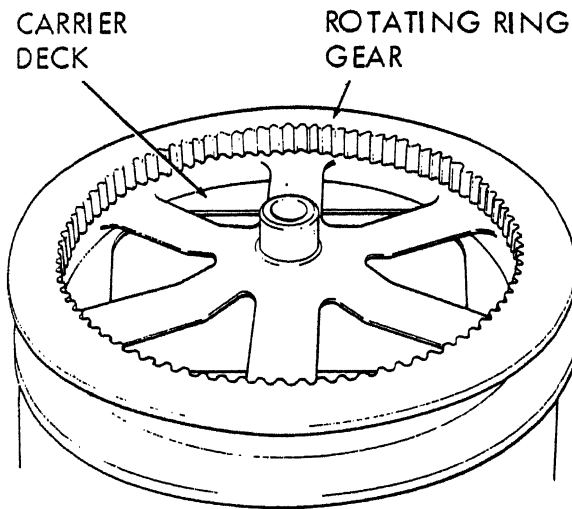
19-37. Cleaning, Inspection and Repair

- Clean all parts with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly.
- Inspect all parts for excessive wear and damage.
- Replace all damaged or defective parts.

19-38. Installation

(fig. 19-14)

- Using a suitable lifting device, position the ring gear properly on the carrier frame.
- Install mounting capscrews.
- Install the crane assembly (para 2-18).



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Figure 19-14. Rotating ring gear, removal and installation.

Section XI. REPAIR OF CARRIER FRAME ASSEMBLY

19-39. General

The carrier frame is an all weld-steel structure with crossmembers, supporting brackets welded integrally with the frame. The carrier frame supports and carries the crane and all components.

19-40. Removal and Disassembly

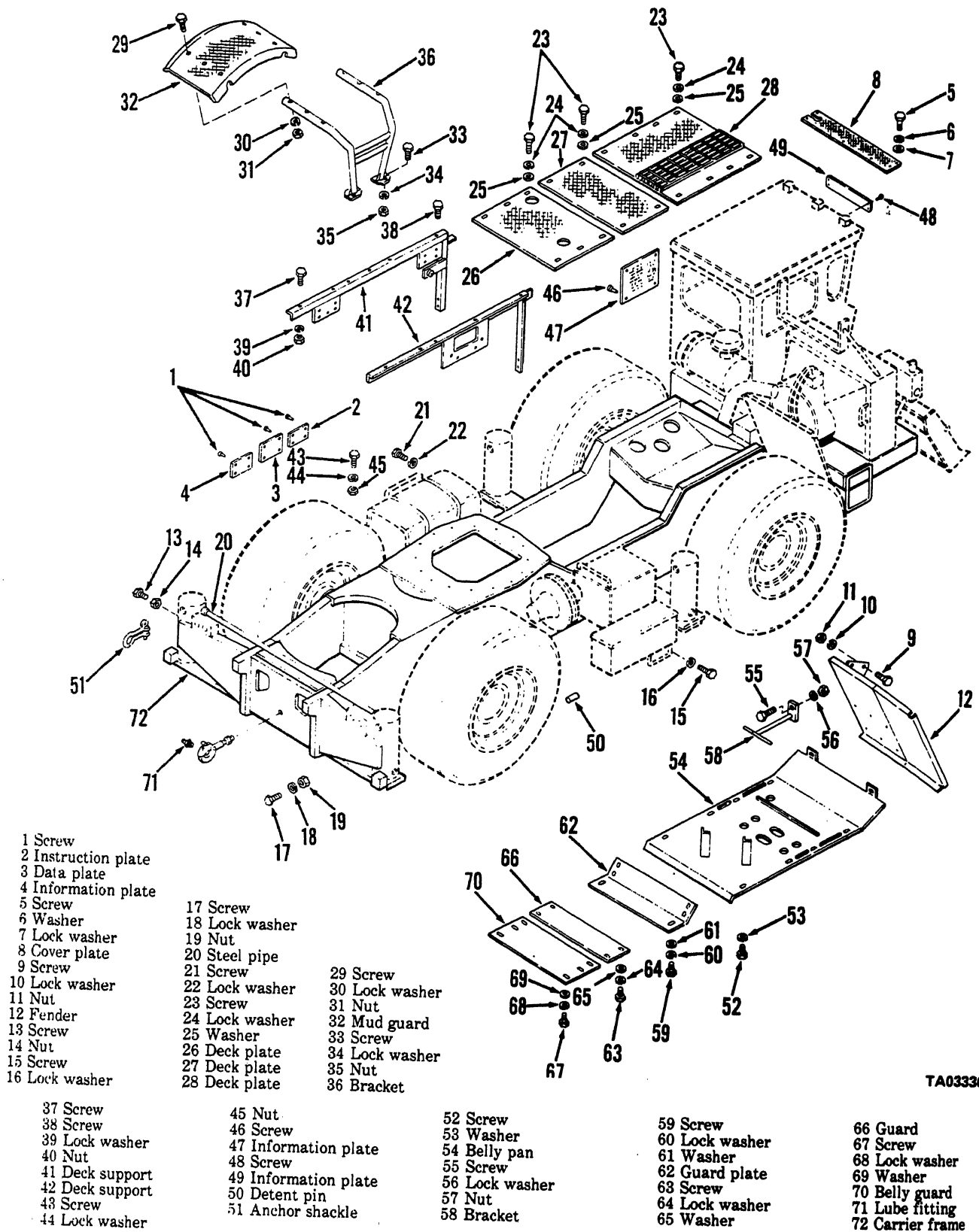
- Remove the carrier frame as described as follows:
 - Remove the crane assembly (para 2-18).
 - Remove the carrier engine assembly (para 2-6).

- Remove the rotating gear (para 19-36).
- Remove the utility blade assembly (para 19-25).

- Remove all major assemblies and subassemblies as described in TM 5-3810-295-12 and this manual.

- Refer to figure 19-15 and disassemble the carrier frame as follows:

- If necessary, remove screws (1) and damaged plates (2, 3 and 4).



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Figure 19-15. Carrier frame—exploded view.

(2) Remove screws (5), washers (6), lock washers (7), and cover plate (8).

(3) Remove screws (9), lock washers (10), nuts (11), and fenders (12).

(4) Remove, if necessary, screws (13), nuts (14), screws (15), lock washers (16), screws (17), lock washers (18), nuts (19), steel pipes (20), screws (21), and lock washers (22).

(5) Remove screws (23), lock washers (24), washers (25), and deck plates (26, 27 and 28).

(6) Remove screws (29), lock washers (30), nuts (31), and mud guards (32).

(7) Remove screws (33), lock washers (34), nuts (35) and bracket (36).

(8) Remove screws (37 and 38), lock washers (39), nuts (40) and deck supports (41 and 42).

(9) Remove screws (46), and information plate (47). Remove screws (48) and information plate (49).

(10) Remove detent pin (50) and anchor shackle (51).

(11) Remove screws (52), washers (53), and belly pan (54).

(12) Remove screws (55), lock washers (56), nuts (57), and bracket (58).

(13) Remove screws (59), lock washers (60), washers (61) and guard plate (62).

(14) Remove screws (63), lock washers (64), washers (65), and guard (66).

(15) Remove screws (67), lock washers (68), washers (69), and belly guard (70) from carrier frame (72).

19-41. Cleaning, Inspection and Repair

a. Clean all metal parts of the carrier frame with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly.

b. Inspect frame for dents, cracks, broken welds and other damage. Check for cracked, broken or damaged parts.

c. Replace damaged parts as necessary. Repair broken welds and cracks and straighten bent or dented parts.

19-42. Reassembly and Installation

a. Refer to figure 19-15 and reassemble the carrier frame as described.

(1) Place belly guard (70) on frame, and secure with washers (69), lock washers (68), and screws (67). Tighten securely.

(2) Position guard (66) on frame, and secure with washers (65), lock washers (64), and screws (63). Tighten securely.

(3) Install guard plate (62), and secure with washers (61), lock washers (60), and screws (59).

(4) Place bracket (58) in position on frame, and secure with nuts (57), lock washers (56) and screws (55).

(5) Install belly pan (54), and secure with washers (53) and screws (52).

(6) Install anchor shackle (51) and detent pin (50) on carrier frame.

(7) Install information plate (49) and secure with screws (48).

(8) Install information plate (47) and secure with screws (46).

(9) Position deck supports (41 and 42) on frame and secure with nuts (40), lock washers (39), and screws (37 and 38).

(10) Place bracket (36) in proper position, and secure with nuts (35), lock washers (34), and screws (33).

(11) Install need guards (32) on supports, and secure with nuts (31), lock washers (30), and screws (29).

(12) Install deck plates (26, 27 and 28) on carrier frame, and secure with washers (25), lock washers (24), and screws (23).

(13) Install lock washers (22), screws (21), steel pipes (20), nuts (19), lock washers (18), screws (17), lock washers (16), screws (15), nuts (14), and screws (13) if removed in disassembly.

(14) Install fenders (12), and secure with nuts (11), lock washers (10) and screws (9).

(15) Install cover plates (8), and secure with lock washers (7), washers (6), and screws (5).

(16) Install plates (2, 3 and 4) and secure with screws (1).

(17) Install all major assemblies and subassemblies described in TM 5-3810-295-12 and this manual.

(18) Install utility blade assembly. (para 19-27).

(19) Install rotating gear. (para 19-38).

(20) Install carrier engine assembly. (para 12-6).

(21) Install crane assembly (para 2-18).

CHAPTER 20 REPAIR OF HYDRAULIC SYSTEM

Section I. GENERAL

20-1. General

a. The hydraulic system utilized on the carrier consists of four pumps, fluid reservoir, relief valves, control valves, cylinders, filters, and necessary connecting tubes and fittings. Hydraulic pressure is used to operate the utility blade, outriggers, and steering power assist. The outrigger system has a hydraulic working pressure of 1850 psi plus or minus 25 psi. The

steering cylinder has a hydraulic working pressure of 1500 psi and the steering control valve working pressure is 650 psi.

b. Repair of hydraulic components not included in this chapter are described and illustrated in the specific repair chapter in which the components are utilized.

Section II. REPAIR OF OUTRIGGERS AND FRONT AXLE LOCK-OUT PUMP

20-2. Description

The hydraulic pump used to supply pressure to the outriggers and axle lock-out system is a single pump mounted on the rear of the carrier engine.

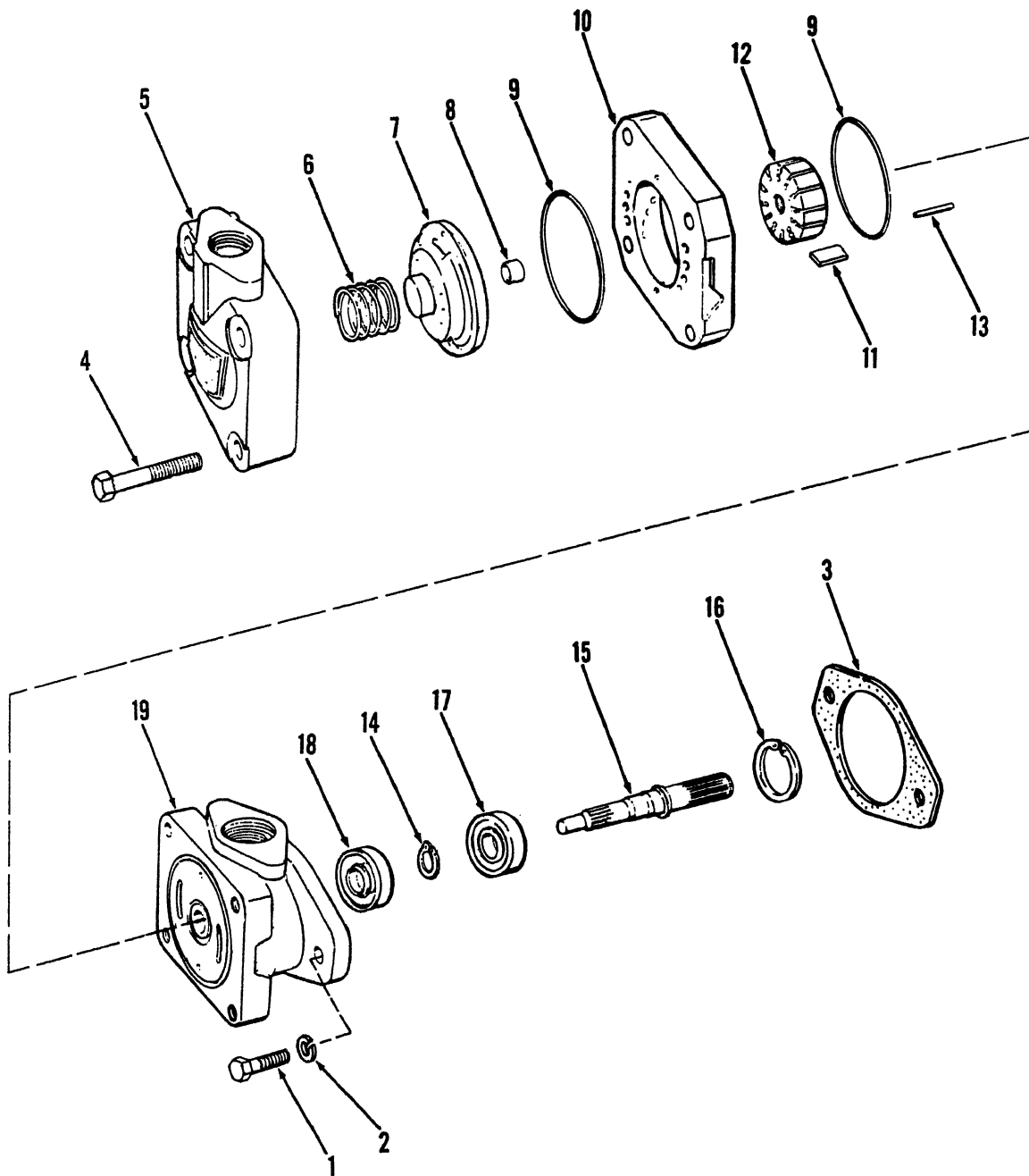
20-3. Removal and Disassembly

a. *Removal.* Refer to figure 20-1 and remove the hy-

draulic pump as follows.

(1) Tag, disconnect all hydraulic lines to the pump.

(2) Remove screws (1), lockwashers (2) and lift pump from carrier engine assembly.



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- 1 Cap screw
- 2 Lock washer
- 3 Pump gasket
- 4 Cap screw
- 5 Cover
- 6 Spring
- 7 Plate
- 8 Sleeve bearing
- 9 Preformed packing
- 10 Rotor ring

- 11 Vane kit
- 12 Rotor
- 13 Pin
- 14 Retaining ring
- 15 Shaft
- 16 Retaining ring
- 17 Bearing
- 18 Seal
- 19 Body

Figure 20-1. Outriggers and front axle lock-out hydraulic pump—exploded view.

b. Disassembly. Refer to figure 20-1 and disassemble the hydraulic pump as follows:

(1) Mark cover (5), rotor ring (10) and body (19) prior to disassembling. Note the direction of arrow cast into rotor ring (10). The arrow indicates the direction of pump rotation.

(2) Place the pump in a clamp vise with protective jaws, cover end up.

(3) Remove pump gasket (3). Remove cap screws (4) and lift cover (5) off assembly.

(4) Remove rotor ring assembly (10) from pump body (19).

(5) Remove spring (6) and plate (7) from rotor ring (10). Remove and discard preformed packing (9).

(6) Carefully pull rotor (12) and vanes (11) out of rotor ring (10). Remove vanes (11) from rotor (12). Note the contour of rotor vanes to avoid error in reassembly. The contour faces out.

(7) Remove pin (13) from pump body (19).

(8) Remove snap ring (16) from the body, and tap shaft (15) and bearing (17) out.

(9) If necessary, remove snap ring (14) and supporting inner race of bearing (17), press bearing off shaft (15).

(10) Remove shaft seal (18) from body (19).

20-4. Cleaning, Inspection and Repair

a. Clean all metallic parts of the pump with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly with compressed air.

b. Inspect wearing surfaces of rotor ring (10), and rotor (12) for scoring and excessive wear. Remove light scoring marks by lapping. Replace badly worn or heavily scored parts.

c. Inspect the vanes for burrs, wear and excessive play in the rotor slots. Carefully dress down burrs with a medium India stone. Replace the rotor if the slots are worn. Replace vanes with a new vane kit if vane tips are scored.

d. Rotate the bearing on the shaft while applying pressure to check for wear, looseness, roughness and pitted or cracked races.

e. Inspect the seal and bushing mating surfaces on the shaft for scoring or wear. Replace the shaft if

marks cannot be removed by light polishing.

f. Be sure that any paint or burrs raised on the body and cover mating surfaces are removed before assembly.

20-5. Reassembly and Reinstallation

a. Reassembly. Refer to figure 20-1 and reassemble the hydraulic pump as follows.

(1) Place shaft seal (18) in body (19) with the spring facing towards bearing (17). Press seal (18) into body (19).

(2) Supporting the inner race of bearing (17), press shaft (15) into the bearing. Install snap ring (14) on the shaft.

(3) Using a soft headed hammer lightly tap the shaft and bearing assembly into body (19). Install snap ring (16) in the body to secure the shaft and bearing assembly.

(4) If removed, install sleeve bearing (8) in pressure plate (7).

(5) Place rotor (12) on pressure plate (7), and insert vanes (11) in the rotor slots with radius edges toward rotor ring (10).

(6) Install locating pins (13) in plate (7). Place preformed packing (9) on rotor ring (10), and place the ring over locating pins (13).

NOTE

Rotor ring arrow must be pointed in the correct direction of rotation.

(7) Install spring (6) in cover (5). Use petroleum jelly to hold spring in place if necessary.

(8) Place preformed packing (9) on rotor ring (10) and assemble cover (5), rotor ring (10) and body (19) together. Secure with cap screws (4). Tighten cap screws to 75—85 ft-lb (101.9—115.3 N·m) torque.

b. Installation. Refer to figure 20-1 and install the hydraulic pump as follows.

(1) Place pump assembly on engine assembly, using gasket (3). Secure with lock washers (2) and cap screws (1).

(2) Reconnect all hydraulic lines to the pump assembly that were removed during the removal operation.

Section III. REPAIR OF UTILITY BLADE AND FAN DRIVE DUAL HYDRAULIC PUMP

20-6. General

The utility blade and fan drive dual hydraulic pump is mounted on the torque converter. One side of this dual pump supplies hydraulic pressure for the utility blade and the steering control system. The other side supplies hydraulic pressure to the fan motor.

20-7. Maintenance

Construction and maintenance procedures of the utility blade and fan drive dual hydraulic pump are identical to the dual steering pump described in chapter 17, section IV.

Section IV. REPAIR OF HYDRAULIC CONTROL VALVES

20-8. General

There are five, hydraulic, spool-type, control valves. The hydraulic shift control, the steering selector control, the outrigger directional control, the utility blade control, and the fan drive control. The maintenance instructions for the steering selector control valve is described in chapter 17, section V.

20-9. Hydraulic Shift Control

a. Removal. Refer to TM 5-3810-295-12 and remove the control valve as described.

b. Disassembly. Refer to figure 20-2 and disassemble the control valve as follows.

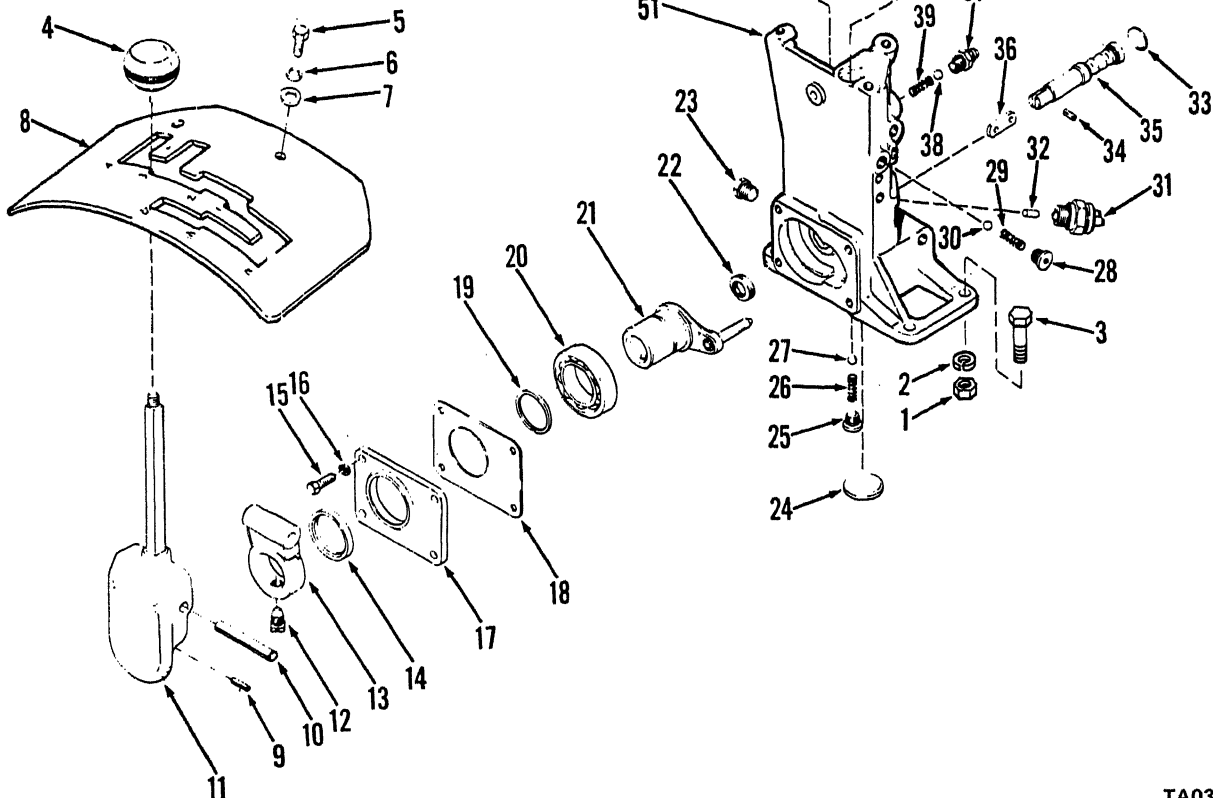
(1) Remove nuts (1), lock washers (2) and cap screws (3) from valve assembly body.

(2) Unscrew knob (4) from lever control (11). Remove plate stop (8) by removing cap screws (5), lock washers (6) and washers (7).

(3) Using a drift punch remove roller pins (9 and 10) and control lever (11) from control assembly.

(4) Remove set screw (12) and pull control lever bracket (13) off assembly.

- | | |
|--------------------------|----------------------|
| 1 Nut | 27 Bearing ball |
| 2 Lock washer | 28 Pipe plug |
| 3 Cap screw | 29 Spring |
| 4 Knob | 30 Bearing ball |
| 5 Bolt | 31 Neutral switch |
| 6 Lock washer | 32 Actuating pin |
| 7 Washer | 33 Expansion plug |
| 8 Stop plate | 34 Roll pin |
| 9 Roll pin | 35 Lock-up spool |
| 10 Roll pin | 36 Spool link |
| 11 Lever housing | 37 Fitting |
| 12 Set screw | 38 Bearing ball |
| 13 Control lever bracket | 39 Spring |
| 14 Oil seal | 40 Retaining ring |
| 15 Bolt | 41 Stop valve |
| 16 Lock washer | 42 Preformed packing |
| 17 Bearing cap | 43 Piston |
| 18 Cap gasket | 44 Spring |
| 19 Retaining ring | 45 Spring |
| 20 Selector bearing | 46 Stop pin |
| 21 Pin assembly | 47 Expansion plug |
| 22 Oil seal | 48 Roll pin |
| 23 Pipe plug | 49 Selector spool |
| 24 Expansion plug | 50 Spool link |
| 25 Pipe plug | 51 Housing |
| 26 Spring | |



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Figure 20-2. Hydraulic shift control—exploded view.

(5) Remove bearing cap (17) by removing bolts (15) and lock washers (16). Remove cap gasket (18) and if necessary remove oil seal (14).

(6) Remove selector bearing (20) and pin assembly (21). If necessary remove oil seal (22).

(7) Remove pipe plug (23) and expansion plug (24) from housing (51).

(8) Remove pipe plug (25), spring (26) and bearing ball (27). Remove pipe plug (28), spring (29) and bear-

ing ball (30).

(9) Remove neutral switch (31) and actuating pin (32) from housing (51).

(10) Remove expansion plug (33) and pull lock-up spool (35) from valve housing. Remove roll pin (34) and separate spool link (36) from lock-up spool (35).

(11) Remove fitting (37), bearing ball (38) and spring (39) from housing (51).

(12) Remove retaining ring (40) and stop valve

(41). Remove and discard preformed packing (42) from stop valve.

(13) Remove piston (43), springs (44 and 45) and stop pin (46).

(14) Remove expansion plug (47) and selector spool (49). Tap out roll pin (48) and separate spool link (50) from selector spool (49).

c. Cleaning, Inspection and Repair.

(1) Clean all metallic parts of the hydraulic shift control with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly.

(2) Inspect all parts for cracks, scoring, corrosion or other defects.

(3) Replace all gaskets, preformed packing and damaged or defective parts.

d. Reassembly. Refer to figure 20-2 and reassemble the control valve as follows.

(1) Place spool link (50) on selector spool (49) and install roll pin (48). Install selector spool (49) and link (50) into housing (51) and secure with expansion plug (47).

(2) Place stop pin (46), springs (45 and 44) and piston (43) into housing (51). Install new preformed packing (42) on stop valve (41) and place the stop valve on piston (43). Secure with retaining ring (40).

(3) Install spring (39), bearing ball (38) and fitting (37) in housing (51).

(4) Install spool link (36) on selector spool (35) and secure with roll pin (34). Place selector spool and link assembly in housing (51) and secure with expansion plug (33).

(5) Install actuating pin (32) and neutral switch (31) in housing (51). Install bearing ball (30), spring (29) and pipe plug (28).

(6) Install bearing ball (27), spring (26) and pipe

plug (25) to housing (51).

(7) Install expansion plug (24) and pipe plug (23) in housing (51).

(8) Install oil seal (22) if necessary, and place pin assembly in housing (51) being sure pin assembly attaches to selector spool link (50).

(9) Press selector bearing (20) over pin assembly (21) into housing (51), and install retaining ring (19).

(10) Install cap gasket (18) and bearing cap (17) and secure with lock washers (16) and bolts (15). Install a new oil seal (14) if necessary.

(11) Install control lever bracket (13) on pin assembly (21) and secure with set screw (12).

(12) Place lever housing (11) on control lever bracket (13) and attach with roll pin (10). Attach lever housing (11) to lock-up spool link with roll pin (9).

(13) Install stop plate (8) over control lever to housing (51) with washers (7), lock washers (6) and cap screws (5).

(14) Screw knob (4) to control lever (11) and mount valve assembly with cap screws (3), lock washers (2) and nuts (1).

e. Installation. Refer to TM 5-3810-295-12 and install the control valve as instructed.

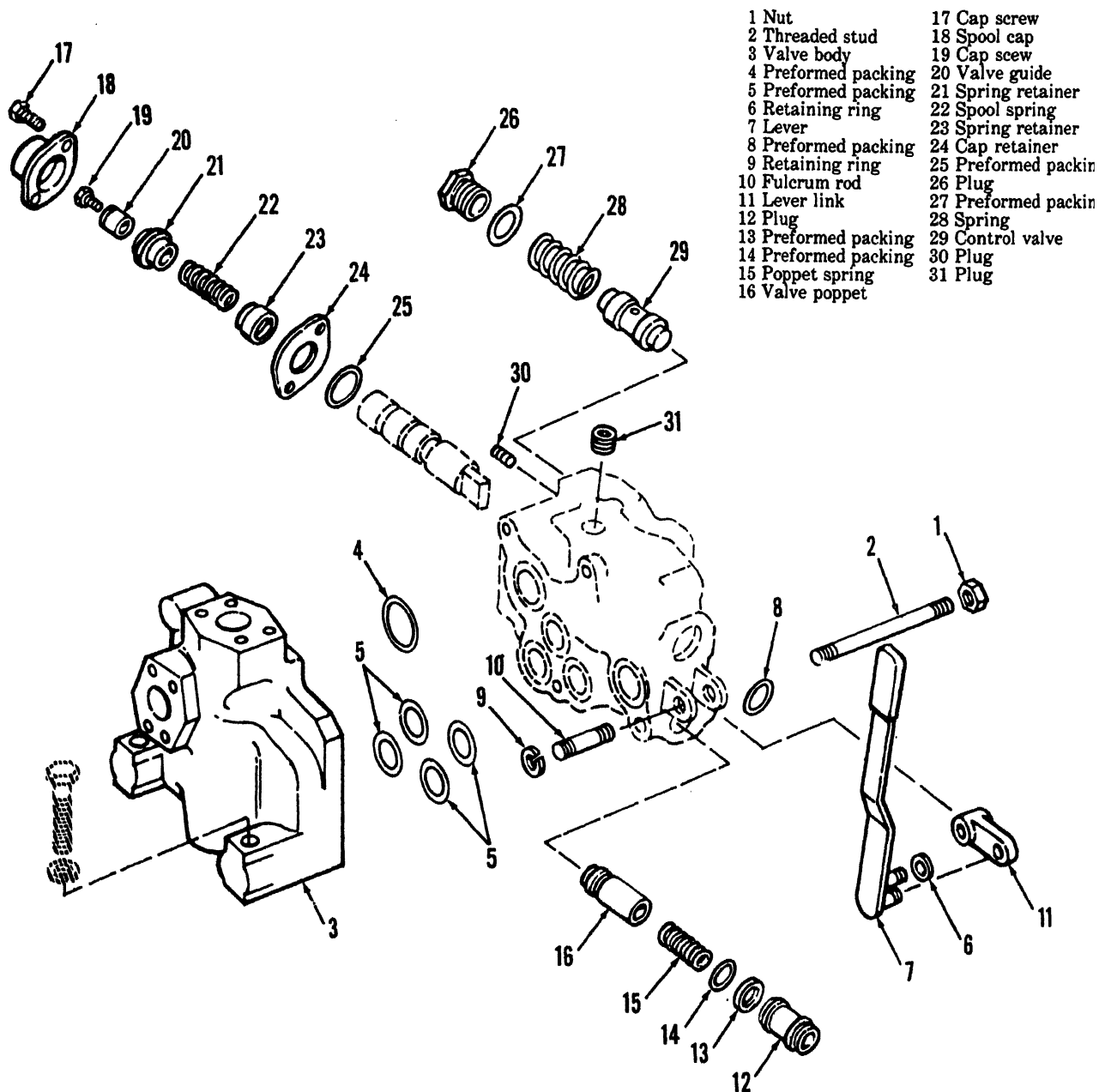
20-10. Utility Blade Control

a. Removal. Refer to TM 5-3810-295-12 and remove the utility blade control as described.

b. Disassembly. Refer to figure 20-3 and disassemble the utility blade control as follows.

(1) Remove nuts (1) and threaded studs (2) and separate body (3) from main body. Remove and discard preformed packing (4 and 5).

(2) Remove retaining ring (6) and pull lever off lever link (11) and valve spool.



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Figure 20-3. Utility blade control valve—exploded view.

(3) Remove and discard preformed packing (8). Remove retaining ring (9), fulcrum rod (10) and lever link (11).

(4) Remove plug (12), preformed packing (13 and 14), poppet spring (15), and valve poppet (16). Discard preformed packing.

(5) Remove cap screws (17) and lift spool cap (18) off main body.

(6) Remove cap screw (19), valve guide (20), spring retainer (21) and spring (22). Lift spring retainer (23), cap retainer (24) and preformed packing (25) from valve main body. Discard preformed packing.

(7) Remove plug (26), preformed packing (27), spring (28) and control valve (29). Remove plugs (30 and 31) from valve main body.

c. Cleaning, Inspection and Repair.

(1) Clean all metallic parts of the utility blade control with cleaning solvent (Fed. Spec. P-D-680, or equivalent), and dry thoroughly.

(2) Inspect all parts for cracks, scoring, corrosion, and other damage or defects.

(3) Replace all preformed packing and damaged or defective parts.

NOTE

Valve body and valve spool must be replaced as a matched unit.

d. *Reassembly.* Refer to figure 20-3 and reassemble the control valve as follows.

(1) Install plugs (30 and 31) in the valve body. Install control valve (29), spring (28), new preformed packing (27) and plug (26).

(2) Install new preformed packing (25), cap retainer (24), spring retainer (23), spring (22), spring retainer (21) and valve guide (20). Secure with cap screw (19).

(3) Install spool cap (18) and secure with cap screws (17).

(4) Install valve poppet (16), poppet spring (15), new preformed packing (14 and 13) and plug (12).

(5) Place lever link (11), on main valve body and secure with fulcrum rod (10) and retaining ring (9).

(6) Install new preformed packing (8) on valve body.

(7) Place lever (7) through lever link (11) and valve spool. Secure with retaining ring (6).

(8) Install new preformed packing (4 and 5) and assemble body (3) to main valve body. Secure with threaded studs (2) and nuts (1).

e. *Installation.* Refer to TM 5-3810-295-12 and install the utility blade control as described.

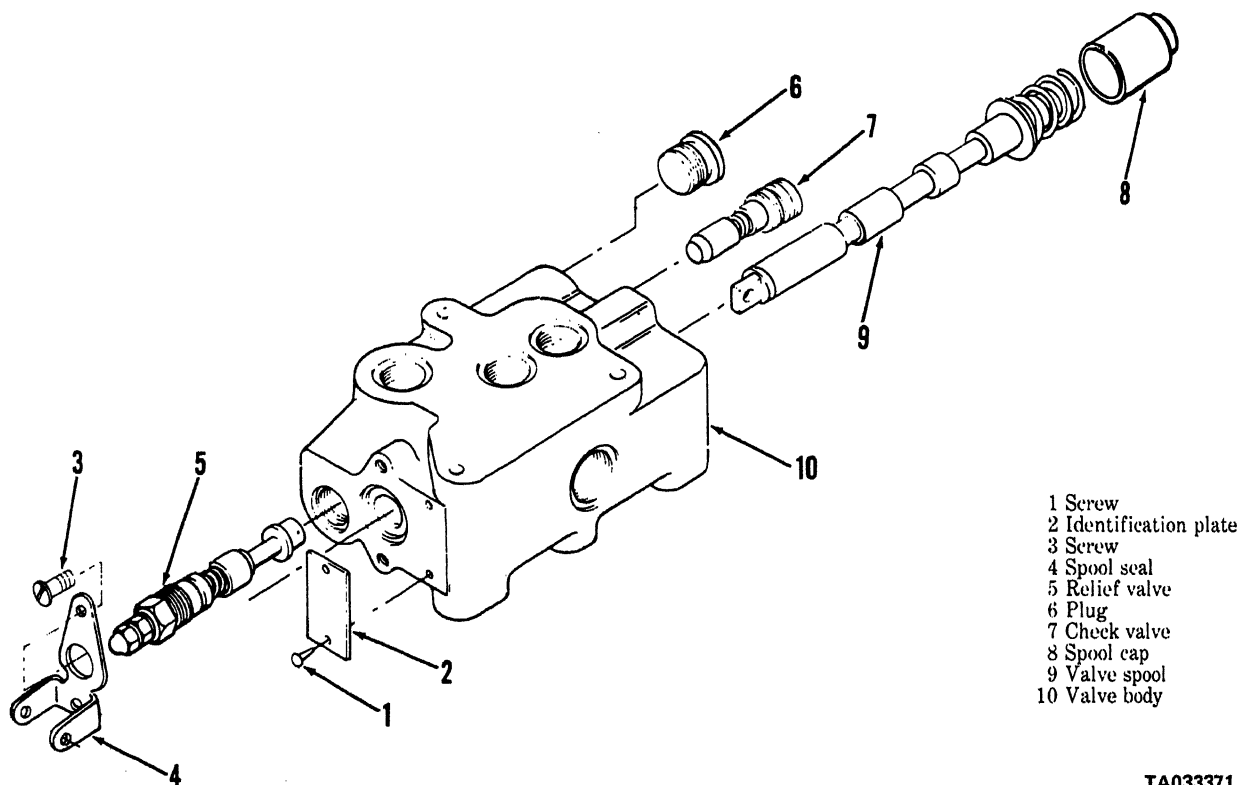
20-11. Fan Drive Control

a. *General.* The fan used to cool the carrier engine radiator is driven by a hydraulic motor. The fan drive control valve provides control for operation of the fan drive motor (54, fig. 13-4).

b. *Removal.* Refer to TM 5-3810-295-12 and remove the fan drive control.

c. *Disassembly.* Refer to figure 20-4 and disassemble the control valve as follows.

(1) If necessary remove screws (1) and identification plate (2) from valve body (10).



- 1 Screw
- 2 Identification plate
- 3 Screw
- 4 Spool seal
- 5 Relief valve
- 6 Plug
- 7 Check valve
- 8 Spool cap
- 9 Valve spool
- 10 Valve body

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Figure 20-4. Fan drive control valve—exploded view.

(2) Remove screws (3) and lift spool seal (4) from valve body (10).

(3) Remove relief valve (5), plug (6) and check valve (7) from the valve body.

(4) Remove spool cap (8) and valve spool (9) from valve body (10).

d. Cleaning, Inspection and Repair

(1) Clean all metallic parts of the fan drive control valve with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly.

(2) Inspect all parts for cracks, scoring, corrosion, and other damage or defective parts.

(3) Replace all damaged or defective parts.

e. Reassembly. Refer to figure 20-4 and reassemble the control valve as follows.

(1) Install valve spool (9) and spool cap (8) into valve body (10).

(2) Install check valve (7), plug (6) and relief valve (5).

(3) Assemble spool seal (4) over relief valve (5) on valve body (10) with screws (3).

(4) If removed, assemble identification plate (2) to valve body with screws (1).

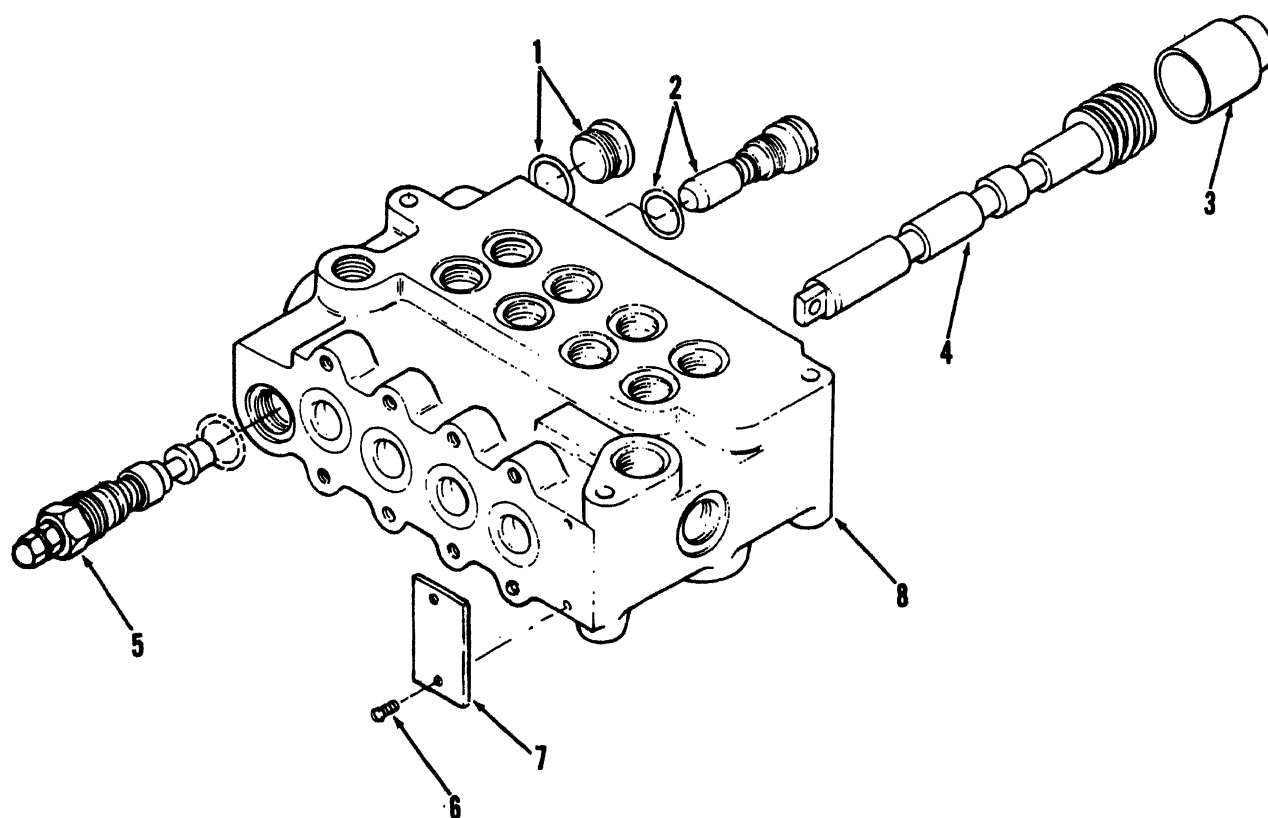
f. Installation. Refer to TM 5-3810-295-12 and install the control valve as described.

20-12. Outriggers Directional Control Valve

a. Removal. Refer to TM 5-3810-295-12 and remove the outrigger directional control valve.

b. Disassembly. Refer to figure 20-5 and disassemble the control valve as follows.

(1) Remove plug and ring (1) and check valve (2) from valve body (8).



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- 1 Plug and ring
- 2 Check valve
- 3 Spool cap
- 4 Direction spool
- 5 Relief valve
- 6 Screw
- 7 Name plate
- 8 Valve body

Figure 20-5. Outrigger directional control valve—exploded view.

(2) Remove spool cap (3), direction spool (4) and relief valve (5) from valve body (8).

(3) If necessary remove screws (6) and lift name plate (7) from the valve body.

c. Cleaning, Inspection and Repair.

(1) Clean all metallic parts of the control valve with cleaning solvent (Fed. Spec. P-D-680, or

equivalent) and dry thoroughly.

(2) Inspect parts for cracks, scoring, corrosion, or other damage and defects.

(3) Replace all damaged or defective parts.

d. Reassembly. Refer to figure 20-5 and reassemble the control valve as follows:

(1) If removed, assemble name plate (7) to valve

body with screws (6).

(2) Install relief valve (5), directional spool (4) and spool cap (3).

(3) Install check valve (2) and plug and ring (1).

e. Installation. Refer to TM 5-3810-295-12 and install control valve as described.

Section V. REPAIR OF HYDRAULIC RESERVOIR TANK

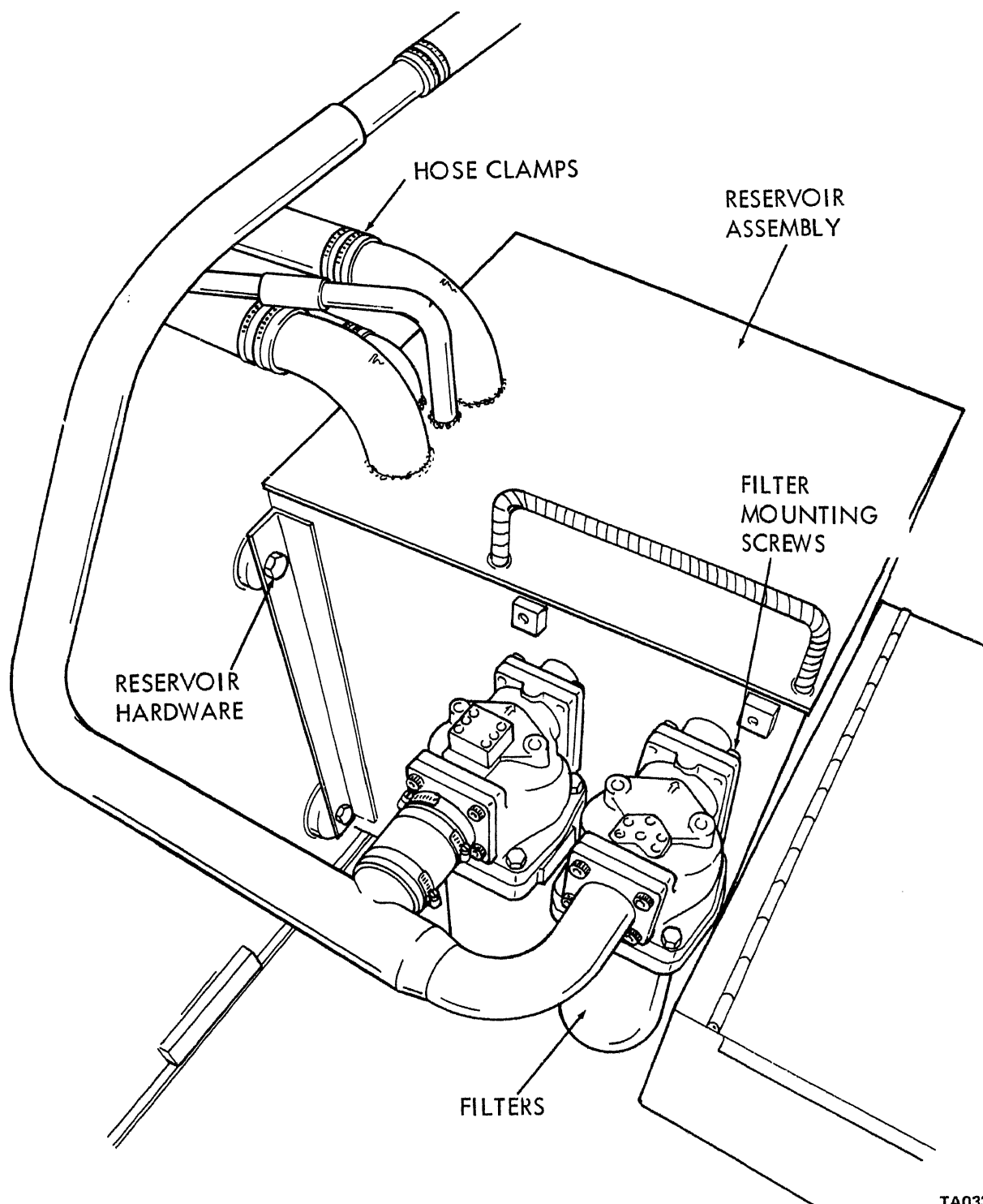
20-13. Replacement

a. Removal. Refer to figure 20-6 and remove the hydraulic reservoir tank as follows:

(1) Drain all fluid from the hydraulic reservoir

into a suitable sized container.

(2) Remove hose clamps above the reservoir tool box assembly.



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Figure 20-6. Hydraulic reservoir and tool box assembly—removal and installation.

(3) Remove hydraulic filters mounting screws.

(4) With a suitable lifting device attached to the hydraulic reservoir and tool box assembly, remove reservoir attaching hardware. Lift assembly off carrier.

b. Cleaning, Inspection and Repair.

(1) Clean all metallic parts of the hydraulic reservoir and tool box with cleaning solvent (Fed. Spec. P-D-680, or equivalent) and dry thoroughly.

(2) Inspect filler assembly and strainer for

damage. Replace all damaged or defective parts.

(3) Inspect reservoir for cracks, breaks, or other damage. Repair or replace defective tank.

c. *Installation.* Refer to figure 20-6 and reinstall hydraulic reservoir and tool box assembly as follows.

(1) With a suitable lifting device, position tank assembly on the carrier frame and install reservoir at-

taching hardware.

(2) Assemble hydraulic filters to reservoir assembly with filters mounting screws.

(3) Install hose clamps above the hydraulic reservoir assembly.

(4) Fill hydraulic reservoir with proper fluid per the current LO 5-3810-295-12 (series).

APPENDIX A REFERENCES

A-1. Publication Indexes

The following indexes should be consulted frequently for latest changes or revision and for new publications relating to material covered in this technical manual:

Military Publications

Index of Army Motion Pictures and Related Audio-Visual Aids	DA Pam 108-1
Index of Administrative Publications: (Regulations, Circulars, Pamphlets, Joint Chiefs of Staff Publications, DOD and Miscellaneous Publications)	DA Pam 310-1
Index of Blank Forms	DA Pam 310-2
Index of Doctrinal Training and Organizational Publications	DA Pam 310-3
Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8 and 9), Supply Bulletins, and Lubrication Orders	DA Pam 310-4
Index of Supply Catalogs and Supply Manuals (Excluding Types 7, 8 and 9)	DA Pam 310-6

A-2. Forms

Refer to TM 38-750, The Army Maintenance Management System (TAMMS), for instructions on the use of maintenance forms pertaining to the material.

A-3. Technical Manuals

Operation and Maintenance of Ordnance Materiel in Cold Weather, (0° to 65°F.)	TM 9-207
Inspection, Care and Maintenance of Antifriction Bearings	TM 9-214

A-4. Lubrication

Crane, Wheel Mounted, 20-Ton at 10-Foot Radius, 2 Engines, Diesel Engine Driven, 4x4 Air Transportable (Harnischfeger Model M320RT)	LO 5-3810-295-12-1, -2, and -3
Fuels, Lubricants, Oils and Waxes	C 9100IL

A-5. Paint

Painting Instructions for Field Use	TM 43-0139
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A-6. Maintenance

The Army Maintenance Management System (TAMMS)	TM 38-750
Inspection, Care and Maintenance of Antifriction Bearings	TM 9-214
Operator's and Organizational Maintenance Manual for Lead-Acid Storage Batteries	TM 9-6140-200-12
Operation and Maintenance of Ordnance Materiel in Cold Weather	TM 9-207
Safety Use of Cranes, Crane-Shovels, Draglines and Similar Equipment Near Electric Power Lines	TB 385-101
Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems	TB ORD 750-651
Safety Inspection and Testing of Lifting Devices.	TB 43-0142 ■

A-7. Shipment and Storage

Administrative Storage of Equipment	TM 740-90-1
Preservation of USAMECOM Mechanical Equipment for Shipment and Storage	TB 740-94-2 ■

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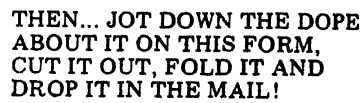
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